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JANUARY 1956

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

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School Science and Mathematics

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SCHOOL SCIENCE
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MATHEMATICS MOTIVATED THROUGH SCIENCE FICTION

IRWIN PORGES
1456 South Durango Avenue, Los Angeles, 35, California

The current interest of school children in science fiction is well known. Television, the screen, radio, and popular periodicals have provided continual stimulation to the younger set with fanciful stories of interplanetary trips, and views of rocket ships, machines and apparatus of the future. While it is true that commercialized advertising has created the most obvious by-product, the eight year old with his space helmet and Buck Rogers gun, a more important reaction is evidenced in the enthusiasm of junior and senior high school students in discussion of space travel, the possibility of life on other planets, and similar topics treated in science fiction.

In the field of astronomy, teachers have become aware of this heightened interest; teachers in other branches of science, and in mathematics as well, will be able to utilize the interest in science fiction to provide a fresh motivation for study. They will find little difficulty in associating aspects of science fiction with their subject fields.

It is conceded that there are many exaggerations and inaccuracies in science fiction; after all, it is "fiction." Nevertheless, it can lead to a healthy curiosity about scientific phenomena, and to a deep appreciation of the scientist or technician and his work.

It is the purpose of this article to take a single theme—a very hackneyed one—from science fiction, and make a few suggestions relating to its use in the motivation of mathematics and biology classes.

A commonplace of the genre is a story featuring a giant insect

possessing muscular power and vitality of such enormity that its destruction can only be accomplished with the aid of cannon and bombing planes. Although no longer popular among the more sophisticated fans, this variety of plot is still used in comic books, (let us face it; our students *do* read the things!) and it hasn't been long since Hollywood made a (financially) successful motion picture on this ancient theme.

Now in applying mathematics, even of the most elementary kind, we must not confuse the mathematical rigor with the more questionable assumptions to which our analysis may be applied. This rather subtle point provides the alert instructor with a valuable opportunity to enlarge on scientific method and logical thought. Once he has admitted the possible fallacy of certain assumptions, the teacher is then free to point out that the conclusions reached on the basis of them are, in this instance, at least plausible, and in conformity with the known data from biology.

We may begin the discussion by noting a fact of nature: that the strength to weight ratio of animals tends to decrease rather rapidly with the increasing size of the individual. An insect, for example, may lift from ten to one thousand times its own weight, as many competent entomologists have testified. Similarly, as reported in a recent issue of *Time*, twenty-five snails, working in unison, could drag a man, so great is their muscular power. An elephant, on the other hand, although able to drag a dead weight of four tons, is obviously not in the same class. Even a vigorous young lion of the feline breed, able to jump over a six foot barrier with a man slung over one shoulder, is weak in comparison with a lowly scarab beetle.

It is true that there are minor variations, but the principle—that increased bulk means proportionately less strength—cannot be challenged. Some apparent exceptions, like the whale, are inadmissible, since the animal is supported by the water, and has a large part of its muscle-power available for propulsion.

Just why strength fails to increase more nearly in proportion to weight is not easily explained. As a sidelight on this point, we may consider the famous "boner" article of Simon Newcomb, "The Flying Machine," in which the distinguished astronomer "proved" the impossibility of heavier than air flight. One of his essential arguments was the demonstrable fact that an airplane, when doubled in size, but keeping its original proportions, increases in weight eight times, while its wing surfaces, which supply lift, are multiplied by only four.

But the biological analogy to this is not too obvious. The all-or-none principle of muscle contraction, accepted by modern physiology, asserts that each muscle fibre either contracts fully or not at all;

that a modification of power, for example, comes about through innervation of fewer fibres rather than a partial contraction of each.

Oddly enough, one of Newcomb's solutions to the power-weight dilemma of flight was the hitching together, in some sort of network, of a great many small flying machines, each with a good power-to-weight ratio. It would seem reasonable that any exceptions among animals might derive from similar considerations: that many tiny fibres, each highly efficient, might give a total muscular power impossible to larger, non-autonomous units. Perhaps that is why a leopard is stronger than a burro of the same weight.

Since we do know, however, that no large animal is as strong in proportion to its size as the smaller ones, what biological reason can be offered? The only explanation for this situation seems to lie in the following assumption, for which there is considerable evidence: the strength of a muscle depends almost entirely upon its thickness—meaning its cross-section area—rather than its length. In other words, a muscle with a cross-section area of say, one square inch, is just as strong when four inches long as when nine inches long.

If we accept this as the basic postulate of our mathematical analysis to follow, the remainder is fairly simple, and easily comprehended by an average class in high school algebra, or even by a bright junior high school group. The amount of mathematical reasoning which can be used effectively by instructors will, of course, depend upon the students' backgrounds.

The subject may be introduced with a general discussion of the strength of organisms; students may even be urged to bring to class science fiction stories which elaborate this theme, and these may be compared with passages from authentic scientific publications which detail the activities and feats of similar organisms. The natural outcome will be a project in which the students will really analyze an insect such as the "giant ant" of science fiction.

The following is offered as a mathematical analysis of the weight-to-strength relation implied in this article:

Given an animal—say an insect—of length L, its weight W will be proportional to the cube of L, or

$$W = k_1 L^3, \tag{1}$$

Using our postulate on muscle strength, we agree that the strength, S, of the insect varies directly with the square of L, since doubling the insect's size merely doubles the linear dimensions (including the diameter) of each muscle, and so quadruples cross-section muscle area. Hence,

$$S = k_2 L^2. \tag{2}$$

Dividing the second equation by the first, and calling k_2/k_1 a new constant, K_3, we have,

$$S/W = k_3/L. \tag{3}$$

From (3) it is clear that with increasing L, the S/W ratio decreases rapidly.

To clarify the mathematics, let us construct a numerical example in accord with nature. Suppose that for an ant we have $L = .01$ feet, and that $S/W = 200$, a modest assumption indeed for an insect Hercules. Substituting $L = .01$ and $S/W = 200$ in (3), we find that $k_3 = 2$, and that for our particular specimen,

$$S/W = 2/L. \tag{4}$$

Now, if we imagine, as in the Hollywood production mentioned earlier, that L is increased to $L_1 = 6$ feet, (4) becomes

$$S/W = 1/3, \tag{5}$$

and we must conclude that our ant, if enlarged to the size of a man, could lift only one third of its own weight, a feat easily surpassed by the most sedentary office worker.

Conversely, for a man reduced in size to that of an ant, we have when $S/W = 1$ (and the average man can lift his own weight), and $L = 6$ feet, the equation,

$$S/W = 6/L. \tag{6}$$

From this we see that if L were decreased to $L_2 = .01$ feet, then $S/W = 600$, and the man would be three times as strong as the insect.

The foregoing mathematical analysis of the relative strength of man and insect is an example of one of the themes which may be drawn from science fiction. Other themes will suggest themselves readily to the mathematics and science instructors. A combination of the unrestrained imagination of the science fiction writer and the methodical, appraising attitude of the teacher, may foreshadow interesting and productive activities in mathematics and science classrooms.

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A "PILOT" AREA FOR DEVELOPMENT OF METHODS OF COOPERATIVE LAND CONSERVATION

SAM DEFLER
Forest Supervisor, Gunnison, Colo.

LAND PATTERN AND USE

In many sections of the Western States, livestock production is the primary economy of the locality. Good pastures, open rangeland, hay meadow land and water supply are essential to the raising of sheep and cattle. These can be assets or liabilities, depending on how the user treats them.

The land ownership and topography pattern in most areas where livestock is the principal crop is quite similar and can be classified as follows:

1. Valley bottoms—represented by lower elevations, deeper soil, and longer growing season. Such areas are usually in private ownership.
2. Foothills land—usually the rolling land above the main stream bottoms, and generally supporting a brush cover such as oakbrush and sagebrush. These areas are sometimes in private ownership but more often are Federal lands administered by the Bureau of Land Management of the U. S. Department of Interior.
3. Timbered Upper Slopes—As the elevation increases so does the annual precipitation and with increase in moisture, the brush gives way to timber land and intermingled range land. Throughout the West, this type of land has generally been set aside as National Forest land and is administered by the Forest Service of the U. S. Department of Agriculture.

It requires all of the above classes of lands to carry on a well rounded livestock operation.

The valley bottoms are limited in size and full summer production from them, of hay and grain, is required to winter livestock when the snow is too deep to allow open grazing. Occasionally some of this type of land is converted to irrigated pasture and is used in the spring and fall for open grazing by stock.

The foothills land generally has to be utilized at a time of year when water is available in streams, springs and ponds for watering of the livestock using the land. Such water is available in the spring following the snow melt and then again in the fall after the late summer rains and early wet snows come. In some areas this type of land is so situated and irrigation water is sufficient to permit limited irrigation and production of greater volumes of feed.

The higher lands are very often snowed in from November through June. This fact dictates that the areas are strictly for summer use. Stock raisers are also anxious to use these higher ranges because the feed is lush at a time of year when the lower elevations provide only hard dry forage. Grazing these areas puts a "bloom" on the stock

that isn't obtained from dry feed, calves and lambs fill out better, and the lower ranges are allowed to rest at a time when continued use would be detrimental to the vigor of individual plants.

This brief picture of topography, weather factors, and vegetative conditions illustrates the reason for the rotational use of land by livestock. It also gives an inkling of the problems of and necessity for good over-all land management.

Management of one sector of the land or management for one purpose only would be relatively simple. However, varied ownership and the other demands placed upon the land add to the complexity of multi-purpose land management. For instance, the majority of water used for domestic, industrial and irrigation purposes is produced at the higher altitudes. Use of the land by livestock has to be compatible with maintenance of the watersheds for production of good quality water in maximum amounts at a time when it is needed most. Watersheds that are abused by poor range or timber cutting practices, fire or road building activities give up their stored water in one big surge and it is generally contaminated with excessive quantities of silt. Silt is the humus and fine soil that makes it possible to grow forage and trees.

Another use over which it is impossible to exercise firm control is use of the land by big game such as deer and elk. Big game move with the season much the same as livestock, except that the date of their movement cannot be controlled to jibe with the date of determined "range readiness." Another improtant difference is the fact that livestock can be and are fed during the winter with products of the land while artificial feeding of deer, especially, has not generally proved successful. Therefore, big game will congregate on favorable exposures at lower elevations where snow depth is at a minimum for the locality. It is not uncommon for several thousand animals to congregate on a relatively few thousand acres for the winter. Such conditions result in heavy damage to the land and loss of game through starvation and from rapid spread of disease through the dense herds.

With the above described ownership pattern, elevation range, and varied uses, it is obvious that it requires unified action to accomplish full land repair treatment of entire drainages. Likewise, all participants benefit from their own work as well as the work of other cooperators.

Application in the Gunnison Area

The land ownership and use pattern described previously is descriptive of the one found in the area around Gunnison, Colorado. A few specific facts that should be added include:

Elevation at Gunnison is 7,700 feet and increases to over 14,000 feet on the peaks that bound the area.

Precipitation at Gunnison averages only slightly over 10 inches per year while at Crested Butte, Colorado, at a higher elevation, it averages nearly 23 inches. Average growing season in the valley is about 71 days. The entire locality is marked by great extremes of temperature. At Gunnison the recorded extremes are minus 47° minimum, to plus 105° maximum, with an average July temperature of 61.5 degrees.

There are approximately 160 operating ranch units within the area.

As early as 1945 certain individuals in the vicinity were seeking ways in which to get something done about increasing grazing forage production on both private and public lands. It was generally recognized that once highly productive lands were now producing only a small percentage of their potential.

Individuals working on the advice of Soil Conservation District personnel were clearing sage brush, seeding lands to introduced grasses, and improving their livestock management practices.

The Forest Service was experimenting with methods of reseeding open range land on a large scale.

The Colorado Game and Fish Department was attempting to find ways to take care of their spring and winter problems which develop from the fact that only limited areas are suitable for winter game range.

The Bureau of Land Management, along with the Forest Service, had long recognized the steady decline in forage production along with increased soil depletion and erosion on Federal lands.

Obviously the problem was everyone's and was so recognized. Solution would call for close cooperation of ranchers and local, State and Federal agencies.

About this same time the National Association of Soil Conservation Districts recognized that similar problems existed throughout the West. A public lands committee was appointed by the NASCD at their annual meeting in February, 1951. This committee studied the problem and obtained passage of the following resolution at that 1951 meeting.

"It is hereby resolved that a comprehensive plan for proper conservation of all lands within one soil conservation district in each state be formulated and that this committee, the National Association, and the public agencies involved, endeavor to secure the necessary funds to carry out this plan."

The Public Lands Committee agreed that one soil conservation district in each of the eleven western states should be selected, to demonstrate what might be done on a coordinated program of

management, development and rehabilitation of public and private lands.

Two meetings of interested individuals and representatives of public agencies followed and on October 2, 1951 the Tomichi and Gunnison Soil Conservation Districts were designated "as the Pilot Area in Colorado to demonstrate common conservation methods, with all interested agencies and livestock groups participating."

"The basic objectives are:

A. The basic physical objectives
   1. To use each acre of land within its capabilities and to treat each acre of land according to its needs for permanent improvement and protection.
   2. To stop the slow decline of productivity of the irrigated lands and grazing lands, and to bring these lands to the height of their productivity, then maintain this production year after year.
   3. To treat the land on a drainage or watershed basis, insofar as it is possible and practicable.

B. How the basic objectives can be reached
   1. Responsibilities. It is clearly recognized by all concerned that expenditure for improvement of lands is the responsibility of the *landowner*, i.e., private land by the rancher, public land by the custodial agency. However, the owner of livestock will primarily benefit from improvement to both private and public land alike; therefore, future management of these lands for improved condition and sustained yield is a major responsibility of the *livestock operator*."

The Job

One of the first jobs to be done was that of inventorying, in detail, the work needed to accomplish the over-all objective of the program. The needs were classified first by land ownership class, (Private or Public). Needs on public land were then broken down to agency responsible for administration, i.e., Bureau of Land Management, Forest Service, State, etc. To go on further, the work was classified as Administrative Needs, Erosion Control, Improvement of Ranges and Timber, and Development and Restoration of Wildlife Areas.

The jobs on irrigated private land run heavy to improvement of water distribution systems, methods of water application, land leveling, renovation of hay meadows through fertilizing, draining, and hay seeding.

Improvement of range land in all classes of ownership include jobs such as contour furrowing, diversion construction, reseeding, stock water developments, management fences, water spreaders, and rodent and noxious plant control.

Up to date base maps, range surveys, land line surveys, range study plots and stream gauging stations were needed.

Erosion control needs included stabilization of gullies, reduction of road and trail erosion, flood control structures and drainage channel improvement.

Jobs, pointed toward improvement of Wildlife Areas, included stream and lake improvement, flood control structures and revegetation with woody shrubs.

Other phases of planning included subdivision of the entire area into units, followed by selection of areas most in need of work that would show the greatest response for the expenditure. This course of action was taken because some areas are definitely submarginal from a cost-benefit ratio standpoint. Responsibility for accomplishment was assigned and work moved ahead as funds, both private and public, became available.

Accomplishments through the calendar year 1953 included:

A. *Public Domain.* The Bureau of Land Management and The Game and Fish Department worked together to get the following work accomplished in the Wood Gulch Area:

Ditches, Water Spreading	1,000 acres
Cleared Sagebrush	1,300 acres
Drilled Grass Seed	1,300 acres
Dams, Erosion Control & Stock Water	15 each
Fences	3.2 miles
Exclosure—Deer & Cattle	1 each

B. *National Forest.* The Forest Service

Ditches, Water Spreading	200 acres
Cleared Sagebrush	1,375 acres
Drilled Grass Seed	1,375 acres
Dams, Erosion Control	4 each
Stockwater Developments	15 each
Fencing	3.8 miles

C. *Private Land.* Private land owners in the Tomichi and Gunnison Soil Conservation Districts have completed the following work on their own land:

Ditches for Irrigation	52 miles
Farm Drainage	802 acres
Open Drains	9.8 miles
Improved Water Application	3,451 acres
Land Leveling (irrigated land)	665 acres
Land Clearing (irrigated land)	399 acres
Pasture Seeding (irrigated)	897 acres
Land Clearing—Sagebrush	673 acres
Seeding Sagebrush Land	712 acres
Irrigation Structures	81 each
Stockwater Developments	10 each
Fencing	2.8 miles
Grazing Management Plan Developed	625 acres

In addition to the accomplishments listed above, the Bureau of Land Management has completed the range survey on a large acreage of land. The Forest Service, in cooperation with the Soil Conservation Service, has produced a new planimetric base map covering the majority of the pilot area. The Soil Conservation Service has worked closely, as has the Agriculture Stabilization and Conservation Committee, with the ranchers and rendered them invaluable assistance

and guidance. The Colorado Game and Fish Department is working out nursery and planting methods for revegetating winter game areas with desirable shrubs with high forage value. The Agricultural Research Service is carrying on experiments and demonstrations to show better methods of irrigating and producing hay of higher quality. Along with this are studies on feeding methods to meet local needs.

Benefits are already being realized from the accomplishments.

The stock watering ponds that were constructed in poorly watered sections have made for better distribution of livestock and more even use of the forage.

Gully plugs with lead-off contour ditches are yielding benefits in 2 ways. They are taking "the punch" out of intermittent heads of water, from summer storms, by diverting the water out of main channels. The water so diverted is returned to the ground and irrigates small areas as it goes.

The reseeded areas show a good catch and after 3 years of becoming established the areas are now being used by livestock on a controlled management basis.

The fact that flood control dams are working is proven by the fact that from two to four feet of silt has collected in them. In one case, it is known that two feet collected in one hard summer storm. Besides retarding the movement of top soil the force is taken out of the flood stage and the lower stream channels show signs of revegetating and stabilizing.

In cases, once live streams (flow yearlong), have gone dry during a part of the season as a result of general vegetation depletion along the stream. The combined land improvement work has restored these streams to their original condition and they now have a yearlong flow. As their condition improves, they will support fish and beaver and serve as a source of livestock water.

The fences that have been constructed have improved the chances of managing stock so that overgrazed areas will not develop.

Under the program, significant acreages of waste land have been brought into productivity through leveling and irrigating, and in places, by draining sour swampy land. Local economy will become healthier as more land is reclaimed and income is stabilized.

This is a brief picture of a program designed to demonstrate the feasibility of cooperatively rehabilitating entire watersheds on which past poor conservation practices have contributed to watershed and range deterioration. Treatment of each practice is impossible in an article of this nature. Complete information on local application of any single practice can be found in books on the various subjects or by inquiry at local offices of the various land management agencies.

EQUILATERAL AND OTHER TRIANGLES ASSOCIATED WITH TRIANGLES

JOHN SATTERLY
University of Toronto, Toronto, Canada

The Morley triangle is a well-known case of an equilateral triangle formed by joining the intersections of the adjacent trisectors of the angles of any plane triangle.

In an old geometry book[1] this problem is stated: "ABC is any triangle and on its sides equilateral triangles are drawn *externally*. If D, E, F are the centers of their inscribed circles show that the triangle DEF is equilateral."

We note that the centers of the incircles are also the centroids of these equilateral triangles, also that in the diagrams the whole triangles need not be drawn but only the lines drawn at $30°$ to the sides of the triangle ABC. These will fix the points D, E, F.

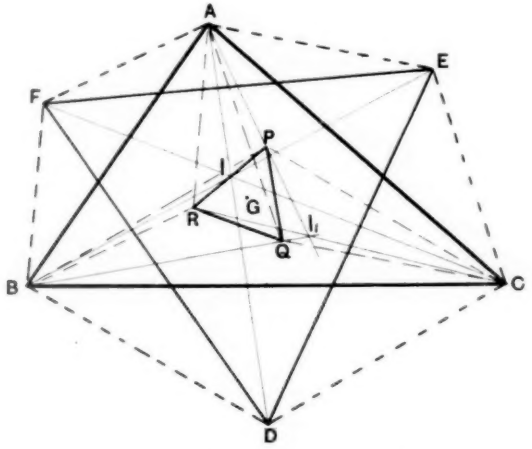


FIG. 1. Equilateral triangles DEF, PQR obtained by joining the centroids of the equilateral triangles drawn externally and internally respectively on the sides of the original triangle ABC. The joins AD, BE, CF are concurrent, also the joins AP, BQ, CR are concurrent.

Fig. 1 shows the construction on an acute triangle ABC. Let $\triangle(ABC)$ denote its area and a, b, c its sides. In the triangle CDE we have $CD=BC/\sqrt{3}=a/\sqrt{3}$, $CE=b/\sqrt{3}$, and $\angle DCE=C+60°$.

[1] Hall and Stevens, A Textbook of Euclid's Elements (Macmillan and Co., London and New York) 1893, Exercises on Book VI, p. 382, No. 59.

Now

$$DE^2 = CD^2 + CE^2 - 2CD \cdot CE \cdot \cos \angle DCE$$

$$= \frac{a^2}{3} + \frac{b^2}{3} - 2\frac{ab}{3} \cos (C + 60°)$$

$$= \frac{1}{3}\left\{a^2 + b^2 - 2ab\left(\cos C \times \frac{1}{2} - \sin C \times \frac{\sqrt{3}}{2}\right)\right\}.$$

Now

$$c^2 = a^2 + b^2 - 2ab \cos C$$

$$\therefore\ DE^2 = \frac{1}{3}\left(a^2 + b^2 + \frac{c^2 - a^2 - b^2}{2} + \sqrt{3}ab \sin C\right).$$

But

$$ab \sin C = 2\,\triangle(ABC)$$

$$\therefore\ DE^2 = \frac{1}{3}\left(\frac{a^2 + b^2 + c^2}{2} + \sqrt{3} \cdot 2\,\triangle(ABC)\right)$$

$$= \frac{1}{6}(a^2 + b^2 + c^2) + \frac{2}{\sqrt{3}}\triangle(ABC).$$

This expression is symmetrical in a, b, c and therefore $DE = EF = FD$, and the triangle DEF is equilateral.

If s = side of an equilateral triangle its area is $s^2\sqrt{3}/4$.

$$\therefore\ \triangle(DEF) = \frac{\sqrt{3}}{4}\left\{\frac{1}{6}(a^2 + b^2 + c^2) + \frac{2}{\sqrt{3}}\triangle(ABC)\right\}$$

$$= \frac{1}{8\sqrt{3}}(a^2 + b^2 + c^2) + \frac{1}{2}\triangle(ABC).$$

What happens if we draw the equilateral triangles *internally* to the sides? We get now the $\triangle PQR$ (Fig. 1).

To find the length of PQ note

$$PC = a/\sqrt{3}, \qquad QC = b/\sqrt{3},$$

and

$$\angle PCQ = 30° - (C - 30°) = 60° - C,$$

and

$$PQ^2 = \frac{a^2}{3} + \frac{b^2}{3} - 2\frac{ab}{3} \cos (60° - C)$$

$$= \frac{a^2}{3} + \frac{b^2}{3} - 2\frac{ab}{3}\left(\frac{1}{2}\cos C + \frac{\sqrt{3}}{2}\sin C\right)$$

$$= \frac{1}{3}\left(a^2 + b^2 + \frac{c^2 - a^2 - b^2}{2} - \sqrt{3}\cdot 2\,\triangle(ABC)\right)$$

$$= \frac{1}{6}(a^2 + b^2 + c^2) - \frac{2}{\sqrt{3}}\,\triangle(ABC).$$

For the side QR the $\angle QAR = A - 60°$ and for the side PR the $\angle RBP = 60° - B$ and since $\cos(\alpha) = \cos(-\alpha)$ the same result is obtained whichever side of $\triangle PQR$ is taken. Hence, this expression being symmetrical in a, b, c, the $\triangle PQR$ is equilateral. Also the area of

$$\triangle(PQR) = \frac{1}{8\sqrt{3}}(a^2 + b^2 + c^2) - \frac{1}{2}\,\triangle(ABC).$$

Note:

1. Sum of the squares of a side of the triangle DEF and a side of the triangle $PQR = 1/3(a^2 + b^2 + c^2)$.

2. Difference between the squares of a side of the triangle DEF and a side of the triangle $PQR = 4/\sqrt{3}\,\triangle(ABC)$.

3. Sum of the areas of the triangles DEF and $PQR = (1/4\sqrt{3})(a^2 + b^2 + c^2)$.

4. Difference between the areas of the triangles DEF and $PQR = (ABC)$.

5. AD, BE, CF are concurrent at I, AP, BQ, CR are concurrent at I_1.

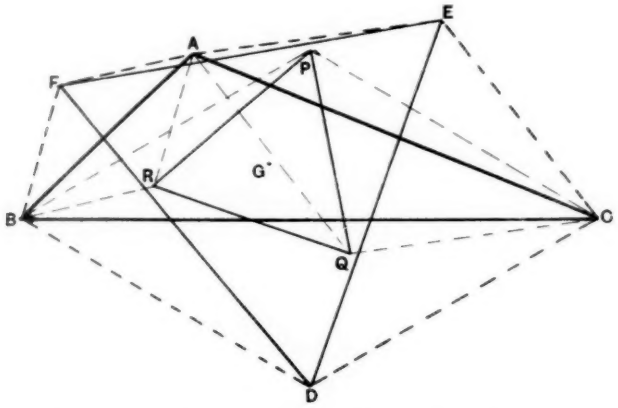
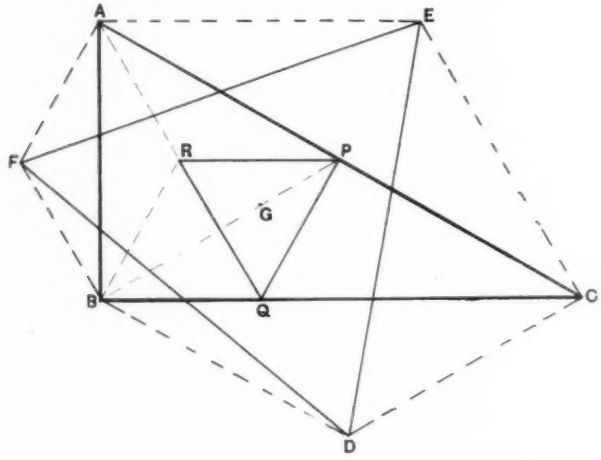


FIG. 2. Equilateral triangle DEF obtained when the angle A of the original triangle is obtuse.

Fig. 2 illustrates the construction for a $\triangle ABC$ having an obtuse angle at A and B and C both $<60°$. The same reasoning applies.

Special cases are shown in Figs. 3, 4, 5 and 6.



[FIG. 3. Equilateral triangle PQR obtained when ABC is a 90°, 60°, 30° triangle.

Fig. 3 shows a right angled triangle where $\angle A = 60°$, $\angle B = 90°$, $\angle C = 30°$. Here P lies halfway along CA and Q one-third of the way along BC from B. In this case

$$DE^2 = \frac{1}{6}(2b^2) + \frac{2}{\sqrt{3}}\frac{b^2\sqrt{3}}{8} = \frac{7}{12}b^2$$

$$PQ^2 = \frac{1}{6}(2b^2) - \frac{2}{\sqrt{3}}\frac{b^2\sqrt{3}}{8} = \frac{1}{12}b^2$$

$$\triangle(DEF) = \frac{7}{6}(\triangle ABC) \quad \text{and} \quad \triangle(PQR) = \frac{1}{6}\triangle(ABC).$$

Fig. 4 shows an isosceles triangle with a right angle at A. The symmetry is marked. In this case

$$DE^2 = \frac{1}{6}(2a^2) + \frac{2}{\sqrt{3}}\frac{a^2}{4} = a^2 \times 0.621$$

$$PQ^2 = \frac{1}{6}(2a^2) - \frac{2}{\sqrt{3}}\frac{a^2}{4} = a^2 \times 0.045$$

$$\triangle(DEF) = 1.077(\triangle ABC) \quad \text{and} \quad \triangle(PQR) = 0.077(\triangle ABC).$$

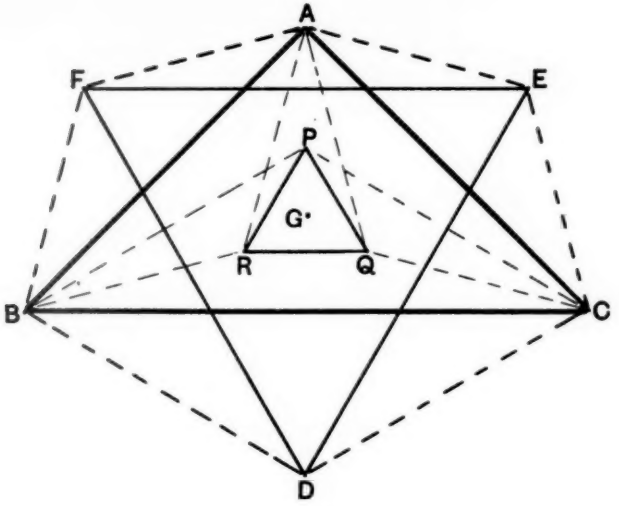


FIG. 4. Equilateral triangle PQR obtained when ABC is a 90°, 45°, 45° triangle.

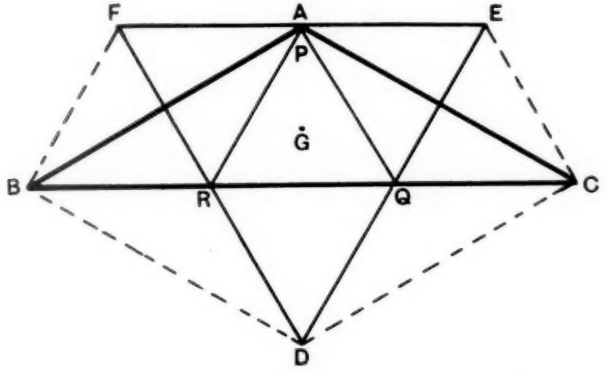


FIG. 5. Equilateral triangle PQR obtained when ABC is a 120°, 30°, 30° triangle.

Fig. 5 shows an isosceles triangle with $\angle A = 120°$. The symmetry is more marked. In this case $DE = (2\sqrt{3})a$, $PQ = (1/3)a$, $\triangle DEF = 4/3 \triangle(ABC)$, $\triangle PQR = 1/3 \triangle(ABC)$.

Fig. 6 shows an equilateral triangle ABC. The symmetry is very marked; obviously $DE = AD$ and $\triangle(DEF) = \triangle(ABC)$. Also P, Q, R all coincide with the centroid of the $\triangle ABC$. Therefore $PQ = 0$ and $\triangle(PQR) = 0$.

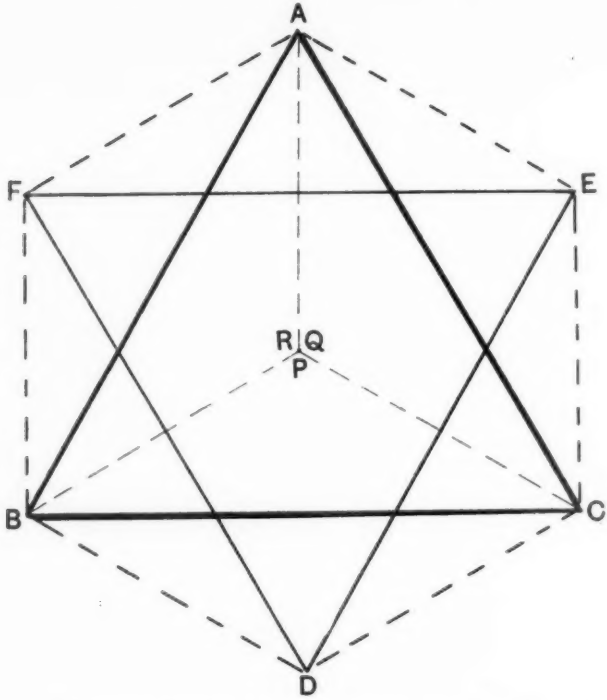


FIG. 6. The original triangle ABC is equilateral. The internal equilateral triangle PQR is reduced to a point.

THE POSITIONS OF THE CENTROIDS OF THE TRIANGLES ABC AND DEF

The centroid of a uniform plane triangle is also the center of gravity of three equal masses placed at the corners of the triangle. This position is found easily by taking moments.

Take B (Fig. 7) as origin, axis OX along BC and axis $OY \perp BC$. Let the coordinates of A, B, C, be (x_1, y_1); $(0, 0)$, (x_3, O), respectively. Let $\bar{x}$, $\bar{y}$ be the coordinates of the center of gravity of the $\triangle ABC$. Then by taking moments about OY we get $1.x_1+1.0+1.x_3=3\bar{x}$ or $\bar{x} = 1/3(x_1+x_3)$ and by taking moments about OX we get $1.y_2+1.0 +1.0=3\bar{y}$ or $\bar{y}=1/3y_1$.

Let $\bar{x}'$, $\bar{y}'$ be the coordinates of the center of gravity of the $\triangle(DEF)$. Let H, K, L be the mid points of the sides of the $\triangle(ABC)$. Join HD, draw $KM \| OX$ to meet a perpendicular EM dropped on it from E and draw LN parallel to OX to meet a perpendicular FN dropped on it from F.

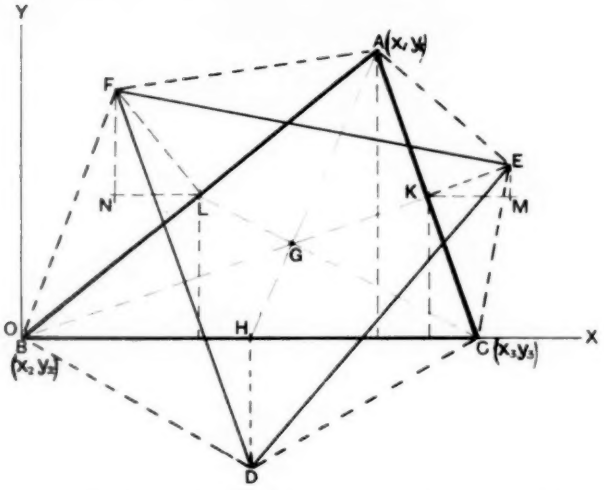


FIG. 7. The figure illustrates the proof that the centroids of the triangles ABC, DEF, PQR are coincident.

The coordinates of D are

$$x = \frac{x_2}{2}, \qquad y = HD = -\frac{x_3/2}{\sqrt{3}}.$$

The x of

$$E = x \text{ of } K + KM = \frac{x_1 + x_3}{2} + KE \sin C$$

$$= \frac{x_1 + x_3}{2} + \frac{b}{2\sqrt{3}} \sin C = \frac{x_1 + x_3}{2} + \frac{y_1}{2\sqrt{3}}.$$

The y of

$$E = y \text{ of } K + EM = \frac{y_1}{2} + KE \cos C$$

$$= \frac{y_1}{2} + \frac{b}{2\sqrt{3}} \cos C = \frac{y_1}{2} + \frac{x_3 - x_1}{2\sqrt{3}}.$$

The x of

$$F = x \text{ of } L - LN = \frac{x_1}{2} - LF \sin B$$

$$= \frac{x_1}{2} - \frac{c}{2\sqrt{3}} \sin B = \frac{x_1}{2} - \frac{y_1}{2\sqrt{3}}.$$

The y of

$$F = y \text{ of } L + FN = \frac{y_1}{2} + LF \cos B.$$

$$= \frac{y_1}{2} + \frac{c}{2\sqrt{3}} \cos B = \frac{y_1}{2} + \frac{x_1}{2\sqrt{3}}.$$

$$\therefore \quad \bar{x}' = \frac{1}{3}\left\{\frac{x_3}{2} + \left(\frac{x_1 + x_3}{2} + \frac{y_1}{2\sqrt{3}}\right) + \left(\frac{x_1}{2} - \frac{y_1}{2\sqrt{3}}\right)\right\} = \frac{1}{3}(x_1 + x_3)$$

$$\bar{y}' = \frac{1}{3}\left\{-\frac{x_3}{2\sqrt{3}} + \left(\frac{y_1}{2} + \frac{x_3 - x_1}{2\sqrt{3}}\right) + \left(\frac{y_1}{2} + \frac{x_1}{2\sqrt{3}}\right)\right\} = \frac{1}{3}\, y_1.$$

Therefore the centroids of the triangles ABC, DEF, are coincident. A similar proof shows that the triangles ABC, PQR also have coincident centroids. Therefore G is the common centroid of the triangles ABC, DEF, PQR.

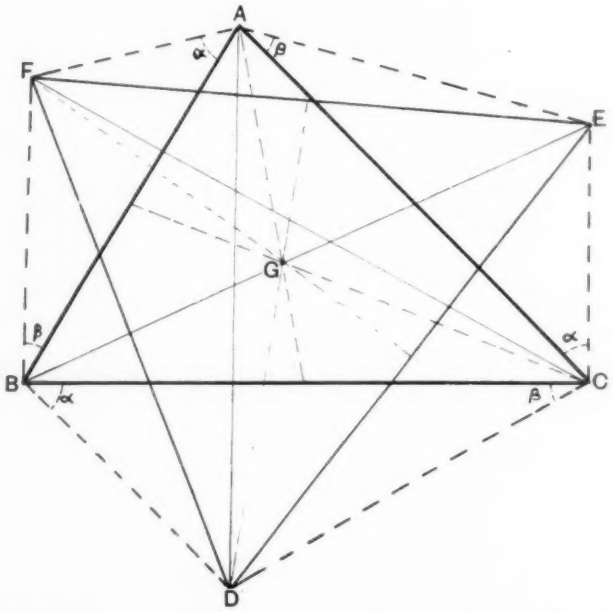


FIG. 8. Similar scalene triangles drawn in order upon the sides of the triangle ABC fix the points D, E, F. The triangle DEF is not equilateral but the centroids of ABC, DEF are coincident. The joins AD, BE, CF are not concurrent.

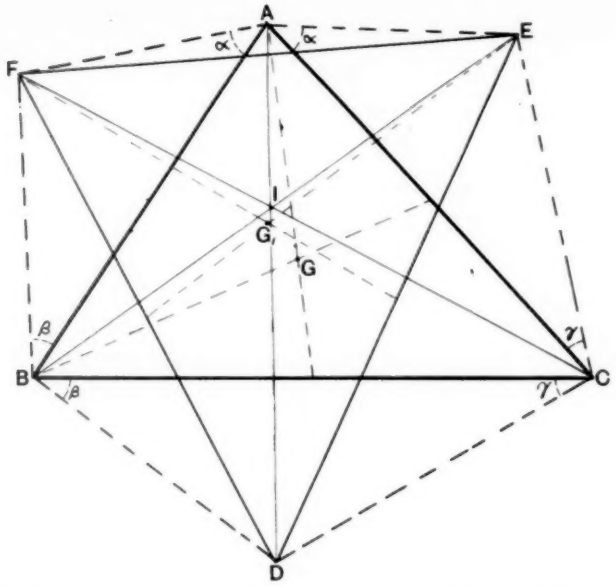


FIG. 9. Scalene triangles drawn upon the sides of the triangle ABC and having their adjacent angles equal fix the points D, E, F. The triangle DEF is not equilateral, nor is its centroid common with the centroid of the triangle ABC but the joins AD, BE, CF are concurrent.

If isosceles triangles of basal angles other than 30° are drawn upon the sides the resulting intersections will not be the corners of equilateral triangles; only in the case of 30° is this theorem true, for the proof depends upon the fact that $\cos 60° = 1/2$.

In all cases, however, as described in a previous paper on the Morley Triangle, etc., the lines AD, BE, CF are concurrent, also the lines AP, BQ, CR.

If similar scalene triangles are described externally upon the three sides of a triangle ABC the shapes of these triangles being taken in order as in Fig. 8 the centroids of the $\triangle$'s ABC, DEF are coincident at G but the $\triangle DEF$ is not equilateral nor are AD, BE, CF concurrent. If however, the scalene triangles are drawn such that $\angle BAF = \angle CAE$, $\angle ABF = \angle CBD$, $\angle BCD = \angle ACE$ as in Fig. 9 the $\triangle$'s ABC, DEF have not a common centroid (see G and G_1) nor is the $\triangle DEF$ equilateral but the joins of the opposite vertices i.e. AD, BE, CF are concurrent at I. Only when the triangles superposed upon the sides of the given triangle have their adjacent angles severally equal are the joins AD, BE, CF concurrent.*

* N. Alliston, Mathematical Snack Bar (Heffer, Cambridge, England) 1936, p. 14.

SUMMARY OF BEHAVIOUR OF THE △'S *ABC*, *DEF*

Nature of the △'s superposed on sides of △*ABC*	△*DEF* is equilateral	Centroids of △'s *ABC*, *DEF* common	*AD*, *BE*, *CF* are concurrent	Figure No. in text
Isoceles △'s of basal angles 30°	Yes	Yes	Yes	1–7
Other isosceles △'s	No	Yes	Yes	—
Similar scalene △'s taken in order	No	Yes	No	8
Scalene △'s with adjacent angles severally equal	No	No	Yes	9

WARNER PRIZES IN CHEMISTRY

The Warner Prizes in Chemistry were won by two students at Carnegie Institute of Technology.

The Warner Sophomore Prize, a three-year membership in the Student Chapter of the American Chemical Society, was awarded to Ira N. Levine, graduate of the Erasmus Hall High School, Brooklyn, New York. He won the award on the basis of his scholastic record at Carnegie.

The Senior Warner Prize, a three-year membership in the American Chemical Society was given to Glenn I. Henricksen from Baldwin Township High School in Pittsburgh. Senior awards are made on the basis of both scholastic achievement and professional promise.

The prizes were established by Dr. J. C. Warner, President of Carnegie Tech and President-Elect of the American Chemical Society. Dr. Warner was former head of the Chemistry Department at Carnegie Tech.

HANDBOOK FOR TEACHING CONSERVATION AND RESOURCE USE NOW AVAILABLE

The best means of helping children understand the importance of our natural resources are expertly described in the "Handbook for Teaching Conservation and Resource Use," a 500 page illustrated book, just completed by the National Association of Biology Teachers.

The publication was prepared by two hundred teachers from thirty states, and shows how they have incorporated conservation and resource-use teaching into the schools. The "How To Do It Stories" and 82 pictures will help other teachers and youth leaders see "How to Get Started," "Where to Get Help," "What to Do in the Classroom," "How to Use the School Grounds and the Community," and how to develop such projects as school forests, school gardens, school camps, wildlife sanctuaries, outdoor laboratories, nature trails, and museums.

The Handbook is available from Richard L. Weaver, P.O. Box 2073, Ann Arbor, Michigan, at a cost of $4.00, with a 20% discount to schools.

To help offset the dangerous cutback in science teaching at the secondary level, Shell Companies Foundation, Inc. announced a broad program of recognition fellowships for 60 high school teachers of science and mathematics each year.

SCIENCE TRAINING FOR PROSPECTIVE SCIENCE TEACHERS

WALTER G. MARBURGER
Western Michigan College, Kalamazoo, Michigan

Much publicity has been given in recent years to the statistical fact that enrollments in high school science courses have not been increasing as rapidly as total high school enrollments, and indeed, in the case of some high school sciences, have actually been decreasing.[1,2] A number of studies of the causes of this disturbing situation have been undertaken, and from these studies analyses, conclusions, and recommendations for improving the status of science work in secondary schools have been made.[1,3] Evidences of concerted efforts to meet what has been called this crisis in science teaching are still quite difficult to find.

Members of the science faculty at Western Michigan College recognized that they were in a stragetic position to attack one local phase of this crucial problem since they are actively concerned with the training of science teachers for the secondary schools of this area. This faculty group was convinced that the most important single factor in the present crisis in science teaching is the science teacher. A resourceful, inspiring, and adequately trained teacher for every science class in our junior and senior high schools would go far to improve the quality of instruction and to increase the holding power of science courses.

Acting on these convictions, the Science and Mathematics Division at Western set up a local committee to investigate how this College could provide an improved type of science training which would prepare more adequately a prospective science teacher for the kind of teaching job for which he is likely to be hired. This committee consisted of:

Haym Kruglak, Chairman of the Physical Science Courses in General Education
George G. Mallinson, Professor of Science Education
Gerald Osborn, Head of the Chemistry Department
William C. Van Deventer, Head of the Biology Department
The writer, Walter G. Marburger, who acted as chairman of the group

Investigation soon disclosed the following facts:

[1] Final Report to the Central Association of Science and Mathematics Teachers. SCHOOL SCIENCE AND MATHEMATICS, 54: 119 (1954).
[2] Kelly, W. C., "Physics in the Public High Schools." *Physics Today*, 3: 12, No. 3, March 1955.
[3] NRC-AIP Conference Recommendations. *Physics Today*, 8: 13, No. 6, June 1955.

TABLE 1

COLLEGE SCIENCE COURSES RECOMMENDED FOR TRAINING PROSPECTIVE SCIENCE TEACHERS FOR SECONDARY SCHOOLS

Teaching Pattern	Biology	Chemistry	Physics	Mathematics	General Education Basic Science	Other Science Courses	Science Methods
A. Biology and General Science In combination with Physical Education	A Basic Course in Introductory Biology (usually 2 semesters) A Field Course (one semester) Additional Courses to total at least a 15-hour teaching minor in Biology				Physical Science (2 semesters)	Meteorology (one semester)	Biology Methods (one semester)
B. Biology and General Science	A Basic Course in Introductory Biology (usually 2 semesters) A Field Course (one semester) Additional Courses to total at least 24 hours (major) in Biology, to include Botanical and Zoological (both vertebrate and invertebrate) areas	General Chemistry (one semester)			Physical Science (2 semesters)	Astronomy (one semester) Geology, including Field Work (2 semesters) Meteorology (one semester)	Biology Methods (one semester)
C. Chemistry Mathematics Physics and General Science		General Chemistry (2 semesters)	General Physics (2 semesters)	Trigonometry (one semester) College Algebra (one semester) Analytic Geometry (one semester) Additional Courses to make a minor (15 hours)	Biological Science (one semester) Human Geography (one semester)	Astronomy (one semester)	Physical Science Methods (one semester)
		Additional Courses to make a major (24 hours) in Chemistry or in Physics or a group major (30 Hours) in a Chemistry-Physics combination					
D. Biology Chemistry Physics and General Science	A Basic Course in Introductory Biology (usually 2 semesters) A Field Course (one semester) Additional Courses in Biology and Geology to total at least 20 hours (group minor)	General Chemistry (2 semesters)	General Physics (2 semesters)			Geology, included in group minor with Biology (2 semesters) Meteorology (one semester)	Biology or Physical Science Methods (one semester)
		Additional Courses to make a major (24 hours) in Chemistry or in Physics, or a group major (30 hours) in a Chemistry-Physics combination					

1. The basic sciences generally taught in the secondary schools of Michigan are biology, chemistry, general science, and physics.
2. Practically none of the graduates of Western receives an initial appointment to teach but one single science subject. An assignment to teach three or more science subjects concurrently is a much more common one.[4,5]
3. The actual teaching assignments of approximately 90% of the teachers of secondary science courses in Michigan fall within one or another of the following categories or patterns:
   A. Biology and general science in combination with courses in physical education and coaching of some form of athletics.
   B. Biology and general science.
   C. Chemistry, mathematics, physics, and general science.
   D. Biology, chemistry, physics, and general science.

It would seem to follow logically that the college science training program of a prospective science teacher should therefore be sufficiently diversified to enable him to teach science courses in at least one of these patterns with assurance, confidence, and a reasonable degree of proficiency. The investigating committee held further that the science training of a prospective science teacher should at the same time have sufficient concentration to enable him to acquire more than a superficial insight into the fundamental principles, the methods, and the basic philosophy of at least one area of science. How to achieve these aims within four years of college and at the same time allow enough hours for the student to meet major and minor requirements in addition to the hours required in the areas of professional and general education will be recognized at once as a problem of monumental proportions.

Table 1 shows the groups of courses recommended by the committee for preparation for each of the four teaching patterns mentioned above. These courses are currently being given by the different science and mathematics departments at Western. No new courses were set up to meet the special needs of any of these patterns.

The courses in these groups are not *required* of students who are preparing to teach science. The primary purpose of the listings in Table 1 is to serve as a guide for prospective science teachers and the counseling staff of this College. The committee is convinced that the courses listed in these groups will provide only the barest minimum of science training for future science teachers. It strongly recommends additional work in chosen science areas whenever time limitations permit.

The courses listed in Patterns B, C, or D will require approximately 50% of the total number of semester-hours of credit that a student can earn in four years of college work. The courses in Pattern A will require approximately 25% of the total semester-hours earned in

[4] Mallinson, George G., and Buck, Jacqueline V. "A Comparison of Characteristics of Positions in Science Teaching with the Characteristics of Teachers Being Trained." *The High School Journal*, 38, No. 1, Oct. 1954.
[5] "The Status of Science Teaching in Michigan." *Newsletter of the MSTA*, 3, No. 2, June 1955.

four years. Science teaching is not the primary interest of a student who would elect to follow Pattern A; physical education and coaching are likely to claim a major share of his time. To be eligible for a teaching certificate in Michigan, the prospective secondary school teacher must earn approximately 20% of his total semester-hours of credit in practice teaching and allied areas of professional education. He must also meet sundry other academic credit requirements in order to graduate at the end of four years. As a result of all these recommended and required courses, precious little time is left over for a prospective science teacher to explore and acquire understanding and appreciation in other important areas of human knowledge and endeavor. It would seem to the writer that science teaching could possibly be made a little more attractive to a student who is considering teaching as a career if his college curriculum could be made more flexible and if a system could be devised and put into effect under which a science teacher in service would not be required to teach such a diversity of subjects concurrently.

AIR FORCE USES FREEZING WATER TO PROTECT FOODS FROM FREEZING

Scientists with the U. S. Air Force have perfected a way to send fresh fruits and vegetables to remote Arctic outposts where temperatures often reach a food-damaging 65 degrees below zero Fahrenheit.

The Air Force method involves placing the fresh-food-stuffs in a fiberboard box, which is in turn nestled in another larger box. Water-absorbent material is placed between the two boxes, which are tightly sealed, and this is saturated with water.

At 65 degrees below zero, it takes about six hours for this water to freeze, and until it does, the temperature remains approximately 32 degrees Fahrenheit in the inner box containing the food. Freezing and spoilage of most vegetables and fruits starts at 30.4 degrees Fahrenheit, so this protects the foods for at least six hours.

NEW INSECTICIDE FIGHTS APPLE FOES, AIDS FRIENDS

U. S. Department of Agriculture scientists have hit upon a "natural" insecticide that controls insect pests while leaving helpful insects relatively unharmed.

Experiments in an apple orchard near Kearneysville, W. Va., showed that the insecticide, called ryania for the tropical shrub it comes from (Ryania speciosa), should prove profitable to apple growers in the East. According to the USDA, ryania shows these advantages:

1. It is selective between harmful and helpful insects.
2. It controls the destructive codling moth, and might prove an excellent reserve defense against DDT-resistant strains of the moth.
3. It does not injure plant tissues, it is comparatively safe for man and animals, and it is one of the few insecticides exempt from residue tolerance limitations on growing crops.

A STUDY OF REMEDIAL ARITHMETIC CONDUCTED WITH NINTH GRADE STUDENTS

DIAGNOSIS

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The problem of remedial teaching has been with teachers for many years. Indeed, if John Dewey's notions concerning the nature of problem solving are applied to this situation, it is not difficult to realize that conditions, which would currently be described as problems for remedial teaching, must have existed long before educators recognized, defined and studied the subject. The review of the literature for this study makes reference to research studies in remedial arithmetic which go back to 1921. No doubt, some work was done by resourceful and understanding teachers before that time.

The birth of this study was the result of the changing curriculum in mathematics in Detroit Public High Schools in 1952. Detroit adopted a revised "three track" program, varying the subject matter taught with the abilities and needs of the groups. The author was scheduled to teach three classes for the lowest group, in Remedial Mathematics. Since the author's training has been largely in guidance, it was natural to view the problem from a clinical standpoint. Subsequent experience led to improved classroom methods and the firm conviction that some means of individualizing this instruction must be found. Under the sponsorship of Dr. C. L. Thiele and other sympathetic administrators in the Detroit schools, a large scale study was organized and carried out over a two-year period.

Many activities took place during the study. The purpose of this article is to describe the testing program which took place, with emphasis on its diagnostic aspects, and its implications for classroom teaching.

TESTING: TWO PURPOSES

In September, 1953, several tests were given to large numbers of entering 9-B students at Cody High School. The program had two purposes:

1. To aid in establishing classification procedures.
2. To aid in defining the problems of remedial arithmetic.

The Iowa Every Pupil Test of Basic Skills, Part D (arithmetic), and the Cody High School Diagnostic Arithmetic Test were among those given. The distributions were studied, and various intercorrelations were examined.

The Cody High School Diagnostic Arithmetic Test is primarily

designed for the purpose of examining error patterns, and obtaining inferences regarding their causes and cure. These aspects were linked to a special scoring system, so that a point score could be obtained for each paper, in addition to the diagnostic statements. A sample of 582 was obtained. A sample of 66 was used to compute the reliability of the test. A coefficient of .92 resulted, when the test was used as a power test.

The subject matter of the Cody test is limited to basic arithmetic computation up to and including decimal numbers. This opens the test to serious criticism, since many important areas of arithmetic are omitted. The limitation was made necessary by the sheer physical problems of a large scale study.

1. Classification Problems

A sample of 326 students were administered both tests. The coefficient of correlation between the scores they obtained was .59. Examination of the data revealed that either test, used as a basis for classifiying individual students, would "misplace" 114 of them, when the other test score is used as a criterion. Since one could argue that the two tests do not measure the same thing, the scores on Part II of the Iowa Every Pupil Test, a section limited to arithmetic computation, were also correlated with the Cody test with a resulting coefficient of .64, and a similar result of 110 "misplaced" students. Numerous qualitative observations were made regarding testing and classification in order to resolve the dilemma presented. The test scores appear no more, nor less, accurate for placement purposes than numerous other criteria which have been used. It can now be argued that the testing situation itself imposes limits upon the predictions which can be made with test results. This is due to a variety of attenuating factors operating as powerfully as the relationships between the tests studied. It is possible that testing carried out under more carefully controlled conditions would not be subject to these factors to the same degree. However, carefully controlled conditions can not be expected in normal public-school operation.

Some of these attenuating factors may be as follows:

1. Items of administration:
   (a) Student misunderstands directions.
   (b) Student is late, and teacher forgets to allow him more time.
   (c) Miscellaneous factors such as broken pencils, etc.

Items in this group are easily corrected by retest, *if someone is aware of the inaccuracy.*

2. Emotional reactions to a test situation:
   (a) Student gets nervous and makes a large proportion of random errors, or a student "freezes up." This may be exaggerated in students new to a school.

(b) Student misjudges time and proceeds to hurry, increasing error, or student misjudges time and works in too leisurely a fashion, thus not finishing.
(c) Student does not care, or is in a state of rebellion toward the adult world, and deliberately gets a low score.
(d) Student is aware of the purpose of the test, and deliberately gets a low score to be placed in an easier class.

None of the items described occur very often. In total, however, they occur often enough in normal school operation to lead to the conclusion that the correlations between tests, and between test scores and achievement will seldom be better than those described here. Tests will generally have less predictive value at the lower end of the scale.

How, then is this problem to be resolved? Placement in a "wrong" section, while serious, is neither fatal, nor inflexible. Students will seldom be "misplaced" more than one category above or below their true abilities. Teachers must be trained to judge these discrepancies. Immediate transfer can be recommended, or suitable promotion for the following semester. Teachers must learn to recognize a situation as dynamic, be prepared to change their minds, and to find surprising changes in students, both positive and negative. The answer lies, not in refining tests and controlling test situations, (which is impossible to the degree needed), but in training teachers to understand these situations, to acquire skill in making objective judgments, and to bring into the problem the degree of human understanding needed to complement the objective information in test scores

2. Defining the Remedial Problem

A checklist of common behaviors in arithmetic deficiency was prepared to accompany the Cody High School Diagnostic Arithmetic test. The list was based on the work of other investigators, principally Brueckner,[1] and on the past experience of the author. Student assistants, recruited largely from the Future Teachers Club, were trained to examine the papers and check off diagnostic items revealed by scrutinizing the incorrect solutions. After the checklists were prepared, the data were coded on McBee Keysort cards, so that percentages, and interrelationships could be studied. To illustrate the method of diagnosis, consider a student's solution to the following test questions:

$$\begin{array}{rr} 8\ 4 & 7\ 3 \\ 6\overline{)48240} & 54\overline{)37962} \end{array}$$

[1] Brueckner, L. J., *Diagnostic and Remedial Teaching of Arithmetic*, John C. Winston Company, 1930. Pages 159-229

A student clerk, observing these solutions, would place a check mark next to the following item:

Omits 0's needed as place holders.

The reader can easily see that these problems could be wrong for many other reasons, which would lead to a different diagnosis. Clerks were instructed to check off an item only if the behavior appeared two or more times. If the student above, for instance, were to omit the 0's in one problem, and solve the other correctly, no diagnosis would be made. The procedure is based on the work of Grossnickle,[2] who distinguishes between chance errors and systematic errors, and concludes that the vast majority of errors made on arithmetic tests were chance errors, not reflective of a lack of knowledge on the student's part.

Several questions must now be answered with respect to this type of procedure. How objective is the diagnosis made? Independent diagnostic checklists were prepared by two different student clerks, for a sample of 50 test papers. The ratio of agreement between the items checked by the two clerks was found to be 59%. This is too low for satisfactory used. The discrepancy occurred because one of the clerks violated the rule stated above, and checked off items for which there was only one wrong solution. The author examined many of the checklists in the remaining papers and his findings agreed more closely with those done by student assistants than the figure of 59% would suggest.

A second question concerns the reliability of the diagnosis. While the reliability of the test *score* was found to be .92, the ratio of agreement of the diagnostic items from test to retest, on the same papers, was 69%.

The disagreements were most often of the type in which the student did a problem wrong two or more times on one paper, leading to a diagnosis, and only once on the other paper, giving an indication, but not a diagnosis. Thus it may be seen that tests of this type must be used for introductory diagnosis only, with the clinical teacher openminded about what else may be found during the teaching relationship. The statistical discussion which follows concerns over-all trends, and the validity of the conclusions is hardly affected by the weakness noted above.

The diagnostic checklist contained a total of 45 items. 529 Keysort cards were prepared, and it was possible to determine the percentage of incidence of each item. The test papers were taken from all elements of the school population, including Algebra, General Mathematics, and Remedial Mathematics students, in approximately the

[2] Grossnickle, Foster E., "Constancy of Error in Arithmetic," *Journal of Ed. Research*, Vol. 32. Pages 336–344, January, 1939; Vol. 33. Pages 189–196, November, 1939.

proportions found in the general school population. For purposes of comparison, the same coding and percentage study was made of a sample of 59 students selected one year later for individual remedial instruction. It is to be expected that the incidence for any particular item ought to be greater in a group especially chosen for remedial instruction than in the student body at large. This is indeed true for 25 of the 42 items in the checklist. The following is an excerpt of the complete table, illustrating the pattern:

Item	Over-all Student Body* (%)	Students Selected for Remedial Instruction† (%)
Does not borrow correctly across 0's (subtraction)	1.1	10.3
Does not understand nature of decimal point in 42—6.7	13.0	74.6
Places decimal points incorrectly (multiplication)	6.4	18.6

However, the most important purpose to be served by comparing the two groups is the discovery of items for which the percentage of incidence is not significantly different. Seventeen items of this type were found. The large number of these items is surprising at first, but a careful examination of their character indicates a remarkable consistency. Fifteen of these items are errors of omission, or errors in which a process is reversed. For example, failure to carry in multiplication, carrying a number not there, or carrying the wrong number, can all be characterized as errors of omission, or the reverse, i.e. inserting a process sometimes used but not required in the example. Subtracting the top number from the bottom can be characterized as a reversal. The other two items deal with the basic multiplication and division tables. It is now clear that a student who responds 7×8 is 63 is often committing an error which presents the same psychological pattern as a reversal. The following excerpt from the complete table illustrates the pattern:

Item	Overall Student Body* (%)	Students Selected for Remedial Teaching† (%)
Carrying numbers not there, or the wrong number	1.5	3.3
Ignores the decimal point (multiplication)	4.7	0
Inverts fractions when multiplying	3.8	5.2

* 529 cases.
† 59 cases.

Errors of omission, reversals of process or response, and errors due to sloppiness are clearly functions of the whole population rather than the group selected for clinical help alone. Perhaps teachers are dealing with a facet of human nature which is a limiting factor, which no amount of instruction will aid. Certainly the presence of calculating machines in offices and laboratories is eloquent testimony for such a point of view.

Many of the items on the diagnostic checklist could be listed in 3 common categories. In order to study the implications of the group diagnosis for teaching, the per cent of the total number of items diagnosed was calculated for each of the groups compared in the previous discussion. The percentage was 80 for the Over-all Student Body and somewhat less for the Students Selected for Remedial Instruction. The categories are:

1. The use of zero in division and multiplication.
2. The borrowing process in all kinds of subtraction, including decimals, fractions, and denominate numbers.
3. Understanding and use of the decimal point in all four fundamental processes.

The percentage of the total is quite high, indicating that both preventive and remedial instruction may well be concentrated in these areas.

These conclusions are generally consistent with the findings of Brueckner and other investigators in the area of error diagnosis. One important difference exists, however, in that most previous investigators have considered the process of carrying in addition and multiplication a major area for instruction. It now appears that few students do not understand *how* to carry. Their errors can be characterized generally as random and unpatterned. Some cases were found in which systematic errors in carrying were due to a failure to write down the number carried. When the student was encouraged to write down the numbers he had to carry, the pattern vanished.

The coding of the diagnostic items on McBee Keysort cards made possible a check of the interrelationships between items, since it was possible to determine the number of cases for which two items appeared on the same paper. The statistical significance of each pairing could be tested by the Chi-square contingency test for paired attributes. Thirteen of the most frequent items were chosen for study, resulting in 78 paired relationships which were counted and tested for significance. The following table shows the results.

Of the 78 paired items studied, forty-two show significant relationships, of which forty-one are positive. It appears that error patterns in arithmetic are not independent items, but part of more comprehensive behavior patterns. The limited information offered by this

CROSS FREQUENCIES OF SELECTED DIAGNOSTIC ITEMS FROM THE CODY HIGH SCHOOL DIAGNOSTIC ARITHMETIC TEST

Item	No.	3	5	9	11	15	18	19	20	24	36	40	41	42	Total
Sloppiness	3		19*s*	20	7	6	3	17*s*	14	11*s*	9*s*	9*s*	13*s*	8*s*	59
Slow worker	5			48*s*	11	4	19	28*s*	25	15	13*s*	24	13	4	101
Decimal Addition 7.1+3.15+16	9				26*s*	16*s*	46*s*	29	45*s*	16	19*s*	39	20	3	133
Reducing fractions	11					7	17*s*	9	20*s*	12*s*	5	29*s*	12*s*	3	50
Borrowing in Subt.	15						12*s*	12*s*	17*s*	11*s*	7*s*	39*s*	8	2	41
Decimal subtract 15.55−3.1	18							27*s*	25*s*	13	7	22*s*	11	1	69
Brings down no. instead of subt.	19								36*s*	10	14*s*	34*s*	15	7*s*	89
Borrowing with denominate numbers	20									16	18*s*	50*s*	21*s*	6*s*	100
Multiplying with 0	24										7	31*s*	8	4	62
0 in division	36											18*s*	10*s*	2	34
Decimal rule in Div.	40												20	2	143
Does not invert-dividing fractions	41													8*s*	68
Inverts wrong fract.	42														12

s = Significantly related by Chi-square contingency test.
n = 529.

sort of analysis could not, of itself, aid in making clear inferences regarding the nature of these patterns. However, it is reasonable to argue the theory that the patterns revealed conform to the theories advanced by Fernald,[3] regarding the causes of arithmetic deficiences. Space does not permit a complete discussion of these theories. In order to present a brief review of them, two primary causal areas for error patterns in arithmetic are argued:

1. Lack of understanding of the number system. The error patterns described above which include 80% of the total can generally be traced to this causal area.
2. Basic personality factors. Symptomatic of this causal area are responses which are sloppy, a result of nervousness, overmeticulousness, lack of incentive, negative social attitudes, etc.

The data presented adds to the mounting evidence that emotional, as well as intellectual factors are major items for teacher consideration.

[3] Fernald, Grace M., *Remedial Techniques in Basic School Subjects*. McGraw-Hill Book Company. Pages 213-259.

SONGBIRDS MUST LEARN THEIR TYPICAL TUNES

Although the ability to sing is inherited, songbirds may have to be taught their tunes, research at the University of Arizona indicates.

Working with both eastern and western species of meadowlarks—each of which has its own typical song—it was found that young meadowlarks isolated from their own species acquire the primary song of other species around them.

SCIENCE STORIES FOR CHILDREN

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INTRODUCTION

During the past few years, books designed for children have been criticized frequently. One of the major criticisms is that those which are easy to read in general deal with naive subject matter. There has been tremendous change in the way people live during the past twenty-five years. Experiences with automobiles, trains and airplanes have become a common part of children's lives. Children no longer are rooted to their communities, but travel to zoos, parks, large cities and rural areas, as well as on long trips to areas not formerly available to them. They no longer "do chores" that occupy their hours. Rather they have time for hobbies, sports, and development of talents. Further, both radio and television have become an important facet of their lives. The breadth of experience they provide is quite evident.

All these changes have influenced the vocabularies that children use and the things in which they are interested. Yet they have not seemed to influence the reading programs in the public schools, or to change greatly many of the materials published for children. As a result children do not become interested in these books that naively describe animal activities and every-day happenings in the city or country. The problem becomes greater when one considers the slow readers in the upper grades. These students are too mature for the contents of these stories but seldom can read anything more difficult. If a teacher does assign these stories to slow readers they lose interest. Seldom will they read more than the assigned material. Hence, the practice they need to become better readers is seldom evident.

The purpose of this article, therefore, is to show how a story with a first grade vocabulary and a fourth grade interest level may be written. Such a story could be a solution to the problem described above.

METHOD

In order to accomplish the purpose, the following steps were taken: (1) the interests of fourth grade children were determined by a review of research; (2) a vocabulary list of first grade words was assembled from the manuals of three basic reading tests; (3) a readability formula was selected for writing the story; and (4) the story was written and evaluated.

CHILDREN'S INTERESTS

What are the reading interests of fourth grade children? No studies

were found that dealt specifically with the fourth grade. However, Stafford (5) made a study of the interests of second graders, which was related to the questions. By means of a questionnaire sent to second-grade teachers in or near Kalamazoo, she discovered that girls prefer fairy tales, animal stories, stories about children, cowboy stories, humorous stories and stories of Indians. Boys like stories about animals, cowboys, Indians, humorous stories, fairy tales and mystery stories. Hence, there is little sex difference in the total picture of interests.

Amatora (6) discovered in her study of records of free time reading, that children from the second through eighth grades prefer stories about animals and children, although interest in animals declines as they grow older.

LaPlante (8) in her questionnaire sent to children of all ages to discover their favorite authors discovered also the popularity of animal stories. Of the top nine authors, four of them were chosen for their stories about animals. Horse stories were found to be favorite with both girls and boys in fourth grade.

Lazar (9) did a study on interests of children of different intelligence levels. She first gave Binet tests to each student between the ages of ten and twelve in her locality. Interviews with these children showed marked sex differences in interests at this level. Girls are interested in fairy tales and boys in adventure stories. It was also discovered the less intelligent boys like girls' books.

In general, these, as well as other studies, also point out several other facts. There seems to be little difference between the reading interest of rural and urban children. Children of all ages like books of action and adventure.

Animal stories and stories about children seem to be most popular with children in second grade through eighth. In fourth grade, children are beginning to get interested in many different types of stories. As this diversification takes place, boys and girls tend to show more and more sex differences in their specific preferences, though they continue to like the same general areas of stories about children and animals.

What qualities make up an interesting book for children? It has been stated already that children like stories of action and adventure. Gates (7) has made many studies to determine what qualities are necessary to make a book interesting for children. The first studies had to do with narrative versus informative material. A selection of each type of literature was read to first, second and third graders. About 70% preferred the narrative material. However, in another study, he had experts evaluate the general literary quality of the material read. They found that the quality of informational material was far inferior to the narrative. When the quality was equated in

the pairs of selections read, only 62% preferred narrative. It was found that the popularity of informative material becomes less and less when read to older and older groups. When the pairs were read to fifth and sixth grades, eleventh and twelfth grades and to a group of juniors in teacher-training school, the preferences shifted from informational material. In the youngest of the groups just mentioned, 52% preferred informational material. In the next 30% and finally only 10% of the college students preferred it. In still another study, thirty selections were read to children in the first through third grades in various pairings in order to compare selections with one another. These yielded a fairly reliable measure of the children's interest in one selection in comparison with the field as a whole. The ratings on interest were then correlated with the ratings on each of fourteen qualities. Since other factors were not constant, the resulting rating did not reveal adequately the influence of each of the fourteen qualities in contributing to or detracting from interest. The most desired qualities are surprise, liveliness, animalness, humor and conversation. Realism and verse do not seem to be related. The best liked compositions are those which incorporate several of the more potent qualities. If one omits entirely from a selection the element of surprise alone, it will require a generous substitution of other qualities to make up the lost appeal to children's interest.

In summary, fourth grade children are likely to be interested in reading a great variety of materials. Special interests are stories of children and animals. Stories should be lively, funny, surprising, about animals or a combination of qualities. The preference for informational material is at its peak around fourth grade. Hence, here is a good place for science stories.

Vocabulary

The lists of words learned in first grade were examined in the three following basic reading texts:

1. Gray, William S.; Artley, A. Sterl; Arbuthnot, May Hill; Monroe, Marion and Gray, Lillian, *Guidebook to Accompany the New Friends and Neighbors.* Chicago: Scott, Foresman and Company, 1952.
2. McKee, Paul; Harrison, M. Lucile; McCowen, Ann and Lehr, Elizabeth, *Teacher's Manual for Come Along.* Boston: Houghton Mifflin, 1950.
3. Russell, David, H. and Oudley, Odille, *Manual for Teaching We Are Neighbors.* Boston: Ginn and Company, 1948.

It was found that each text exposed the children to about 300 words in first grade. The three texts had about one-half their words in common. About one-third more were found to be used by two of the texts. A list follows of words found in two or three of the texts. Only root words are listed. Endings of "s," "ing" and "ed" will not be noted.

a
about
after
again
airplane
all
alone
along
am
an
and
apple
are
around
as
ask
at
ate
away
baby
back
bag
ball
barn
be
began
behind
big
Bill
birthday
black
blue
boat
book
bow-wow
box
boy
brown
bump
Bunny
but
by
call
came
can
can't
cat
children
cold
color
come
could
cow
dark
day
Dick
did
dinner
do
door
dog
don't
down
duck
eat
egg
father
farm
fast
feet
find
fire
first
fish
five
fly
for
found
four
from
fun
funny
gate
get
girl
give
go
good
good-by
green
guess
had
happy
has
have
he
head
hear
heard
help
hen
her
here
hill
him
his
home
hop
horse
house
how
hurry
I
if
in
into
is
it
Jack
jump
just
kitten
know
laugh
let
let's
like
little
long
look
lost
made
make
man
many
may
maybe
me
met
new
milk
mitten
money
morning
mother
Mr.
Mrs.
must
my
never
new
next
night
no
not
nothing
now
of
oh
old
on
one
or
other
our
out
over
paint
party
pet
pig
play
please
pocket
pony
pretty
put
quack
rabbit
race
rain
ran
red
ride
run
said
sand
sat
saw
say
school
see
she
sleep
snow
so
some
something
soon
splash
squirrel
stop
store
story
street
surprise
Susan
take
thank
that
the
them
then
there
they
thing
think
this
three
time
to
tomorrow
Tom
too
took
toy
tree
two
under
up
us
very
wagon
walk
want
was
water
way
we
wee
went
were
wet
what
when
where
which
white
who
why
will
win
wish
with
woman
work
yard
yellow
yes
you
your

Readability

Vocabulary is only one factor in readability. Two others are taken into consideration in a readability formula made up by Wheeler and Smith. They are the percentage of polysyllabic words and length of sentences. Their aim was to find a formula for readability which would be applicable to early grades. The Flesch and Dolch formulas were the basis from which they started. The method used in creating this formula was to take a random word count of nine basic reading series and find the mean percentage of polysyllabic words for each level and the mean unit length for each level. The combined means were set up as the criterion for each level. The formula and table follow.

1. Take a random sample of ten to twenty pages of the book.
2. Count the number of words in the sample.
3. Count the number of units in the sample. Count as units sections ending in question marks, period, exclamation points, colons, semicolons or dashes. In counting a unit of conversation include the "said John," "he asked" and so forth as part of the unit.
4. Count the number of polysyllabic words in the sample.
5. Divide the number of words in the sample by the number of units. This will give you the average unit length.
6. Divide the number of polysyllabic words in the sample by the number of words. This will give you the percentage of polysyllabic words.
7. Multiply the average unit length by the percentage of polysyllabic words. (Don't forget the decimal point!) Multiply this score by ten.
8. Take the figure obtained in step 7 and go to the table for grade placement.

Table of Norms

Primer	4.0– 8.0
First Reader	8.1–11.5
Second Reader	11.6–19.0
Third Reader	19.1–26.5
Fourth Reader	26.6–34.5

Every book for independent reading should be put down one grade level.

Other Aspects to Be Considered

Besides using a first grade vocabulary, using the readability formula and applying the information collected about children's interests, other factors must be taken into consideration. The number of new words should be kept to a minimum. When a new word is introduced, it must be surrounded by a context which will be a good hint as to what the word is. It is a premise in writing, that the author should have personal experience with the subject about which he writes. It is also a principle in writing to have a title which creates interest and gives an idea of the type of story it heads.

From all these considerations an attempt to produce the desired type of story was made. It follows.

A Night Alone

"Good-by, boys," said Mother and Father. "We will be back soon."

"Good-by," said Jack and Bill.

Bill went back to his coloring. Jack began reading his horse book.

"What was that?" asked Bill.

"I heard nothing," said Jack.

Bump, bump, bump. Jack heard the *n*oise this time.

Bill's *e*yes jumped out of his head. "It's ghosts," he said. "Big bad ones like on T.V."

"The noise is coming from up in the *a*ttic," said Jack. "What can it be? It can't be a man. No man could get in. Maybe some squirrels got in again. Some did before. Or maybe it is that little *m*ouse Mother saw up there. It scared her so! She put a *t*rap up there for it."

"But squirrels don't make big noises like that. And a mouse makes no noise at all. It is a ghost!" said Bill.

"There is no such thing as a ghost, Bill. You know that! But something is making the noise. Let's go see what it is!"

"No-o! No-o-t-t me!" said Bill. "I'm scared."

"O.K., I will go up alone." Jack went up the stairs. He looked here and there. He saw nothing. But behind the toy barn! Two eyes were looking at him! Jack walked to the barn. He jumped back in surprise! He laughed. There sat a scared squirrel. On his *t*ail was a big mouse trap.

"How funny!" Jack laughed. "That trap is there for a mouse, not you." He took the trap off the squirrel's tail. Jack took him down the stairs.

"Here's your ghost!" he said.

Bill looked from behind the attic door. "He is more scared than I was!"

The boys took him to the back door.

"Good-by," they said to the squirrel. He ran to a tree. He was gone in no time.

"Boy, did he run! That is the most happy ghost I ever saw," said Bill.

"And the only one you ever will see," laughed Jack.

Evaluation

Interest? The story is about children, one of the two main interests of elementary-school children. In qualities, this story contains several —humor, conversation and most important, surprise. The one quality it may lack is liveliness. Other qualities may make up for this lack.

Vocabulary? In addition to the listed first grade vocabulary, nine words were introduced. They were noise, eyes, ghosts, attic, mouse, scared, trap, tail and stairs. These words are definitely needed for the plot. All of the words are introduced in contexts which give the reader a fairly good clue as to the correct word.

Readability? There are 325 words in the story. There are 56 sentences. Dividing the words by the number of sentences gives an average of 5.8 words per sentence. There are 35 polysyllabic words. This number divided by the number of words in the story gives a percentage of 10.8% or .108. When the percentage is multiplied by the average number of words per sentence and then multiplied by ten, the readability score comes out 6.264. On the readability table, this is in the primer range. Since books for independent reading should be put down one grade level, and the author was using a first grade level, the story is fine as far as readability goes.

Author's experience with subject? A variation of the situation took place at the author's home several years ago. However, in reality the intruder was a big rat which was caught in the trap. It was his

death struggle that made the noise, so it was necessary to change the original happening in order to write a suitable story for children.

Title? It is not good but all the key words which would have created interest and given a better idea of the content of the story are new words which had to be introduced in a clue-giving context.

Success? The story seems to have the contents of an interesting, easy reading story, insofar as research is indicative. It will be up to the children who read it, however, to make the final decision if this story can serve successfully the purpose for which it is intended.

Bibliography

Reference Books

1. Carter, Homer L. J. and McGinnis, Dorothy, J. L., *Learning to Read.* New York: McGraw-Hill Book Company Inc., 1953. Pp. ix+214.
2. Gray, William S.; Artley, A. Sterl; Arbuthnot, May Hill; Monroe, Marion and Gray, Lillian, *Guidebook to Accompany the New Friends and Neighbors.* Chicago: Scott, Foresman and Company, 1952. Pp. 256 (manual +272 (textbook).
3. McKee, Paul; Harrison, M. Lucile; McCowen, Ann and Lehr, Elizabeth, *Teacher's Manual for Come Along.* Boston: Houghton Mifflin, 1950. Pp. 254 (manual)+255 (textbook).
4. Russell, David H. and Oudley, Odille, *Manual for Teaching We Are Neighbors.* Boston: Ginn and Company, 1948. Pp. iii+283.

Master's Thesis

5. Stafford, Dixie Lee, "A Survey of Interests in Literature of Second Grade Children in Kalamazoo County." Unpublished master's thesis, University of Michigan, Ann Arbor, Michigan, 1951. pp. iv+56.

Periodicals

6. Amatora, S. M. and Edith, S. M., "Children's Interest in Free Reading." *School and Society,* LXXIII (March 3, 1951), 134–37.
7. Gates, Arthur I.; Peardon, Celeste Comegys and Sartorius, Ina Craig, "Studies of Children's Interests in Reading." *The Elementary School Journal,* XXXI (May 1931), 656–70.
8. LaPlante, Effie, "A Survey of Reading Interests." *National Elementary Principal,* XXXI (September 1951), 126–33.
9. Lazar, May, "The Reading Interests, Activities and Opportunities of Bright, Average and Dull Children." *Teachers College Record,* IXL (November 1937), 153–154.
10. Rudman, Herbert C., "The Informational Needs and Reading Interests of Children in Grades IV Through VIII." *Elementary School Journal,* LV (May 1955) 502–512.
11. Tooze, Ruth, "Some Good Books for Slow Readers." *Book News from Ruth Tooze,* Mimeographed periodical, Michigan City, Indiana, April 1953, 1–30.
12. Wheeler, L. R. and Smith, E. H., "A Practical Readability Formula for the Classroom Teacher in the Primary Grades." *Elementary English,* XXXI (November 1954), 397–399.

Bulletin

13. Durrell, Donald D. and Sullivan, Helen Blair, *High Interest Low Vocabulary Booklist.* Boston University School of Education, Educational Clinic, Boston, 1952. Pp. 45.

COLLEGE MATHEMATICS FOR THE NON-SCIENCE, NON-MATHEMATICS MAJOR

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INTRODUCTION

Our scientific age has progressed to the point where it is apparent that if this nation is to maintain its place in world progress a great many people are needed with:

1. Training in areas requiring a strong sequence in traditional mathematics such as that required for engineering; and
2. Training in the fundamental concepts of mathematics which make it possible to understand our scientific age, to handle jobs not involving rigorous mathematics, and to handle the mathematics of everyday living.

This paper is not concerned with the mathematics concepts ordinarily found in traditional mathematics courses. Rather it is concerned with the training of students not desiring to specialize in science or mathematics, but who will provide the country with those skills involving the application of basic mathematical principles.

For the sake of clarity the course that deals with mathematical concepts for non-science, non-mathematics majors will be referred to henceforth as "general mathematics."

The number of people graduating from the colleges and universities of the United States has increased substantially every year since 1945. In 1952–53 there were 200,820[1] college graduates. Of these there were 22,942[2] who received degrees in areas requiring a strong sequence in mathematics such as civil engineering, electrical engineering, mathematics, and mechanical engineering.

Therefore, assuming the ratio of strict science majors to the total number of graduates for 1952–53 is typical, the number of students receiving degrees in the last decade in which little or no mathematics is required is substantial. However there has been a steady growth of employment opportunities that involve simple mathematics, logical reasoning, elementary statistics and numerical validity.

Thus there arises a question as to the adequacy of the basic program of mathematics for a vast number of college graduates. Can a person be considered truly educated without some mathematics? Can he be considered educated without being capable of handling elementary concepts of mathematics such as the following.

1. The basic factual information and skills of arithmetic and geometry.
2. The ability to interpret variable relationships.

[1] Dan Golenpaul Associates, Chart Entitled "Degrees Granted by Institutions of Higher Learning." *Information Please 1955 Almanac*, New York: Macmillan Company, pp. 255.
[2] *Ibid.*

3. The ability to apply critical judgment, form hypotheses, to draw valid conclusions, to interpret results, and to present data understandably.
4. The ability to understand and analyze the relations of quantity and space.
5. The ability to understand elementary statistics.
6. The ability to apply critical thinking and abstract reasoning to life situations.
7. An appreciation of the part mathematics has played in the development of our civilization.

Attempts to Answer the Question

During and immediately after World War II many colleges and universities examined the courses they were offering in mathematics in an attempt to determine how they might better meet the needs of their students. As a result of this appraisal and the implications drawn from the check list used in the "Report of the Commission on Post-War Plans of the National Council of Teachers of Mathematics," there has evolved a general belief that two programs of mathematics should be offered to college students, one for the student intending to specialize in areas demanding traditional mathematics, the other for the student not so intending. The latter courses should be designed to meet the mathematical needs of students planning for careers in teaching (other than mathematics or science), business administration, accounting, pharmacy, insurance, social sciences, and even for stenographers who are likely to work for engineers or theoretical mathematicians.

Research indicates that in spite of the feeling that mathematics deserves a place in the general education of all students there is no general requirement of mathematics for graduation from the colleges and universities of the United States. Cameron[3] reports that in visiting the mathematics departments of thirty-three American colleges and universities he found only four which required mathematics for graduation. In three, mathematics or philosophy is required. He also reports that he encountered some mathematics departments that were not concerned with the mathematics needed for liberal education. A number of other departments believed that the mathematical needs of all college students could be met automatically by the traditional introductory courses. Fortunately, he did find that some individual members of such departments were vitally interested in mathematics for general education but at the moment were unable to implement their thoughts in terms of new course content or organization.

Another factor contributing to the delay in making general mathematics a required course for graduation has been the lack of acceptable textbooks. In general many of them have fallen into one of two

[3] E. A. Cameron, "Some Observations on Undergraduate Mathematics in American Colleges and Universities," *The American Mathematical Monthly*, LX (March, 1953), 151–155.

categories. The first group includes those in which the major topics deal with arithmetic skills, consumer credit, insurance, investment and taxation, and how to balance a checking account. This does not suggest that these topics should not be included in such a course. However, these topics should not alone constitute the course.

The second group includes those texts in which the concepts considered most important to college algebra, trigonometry, analytic geometry, and calculus have been collected and put into one book. This has resulted in a segmented type of course which leaves the student the responsibility of finding applications for the various ideas presented. This approach is ineffective because such transfer without impetus from the instructor just doesn't occur.

Guiding Principles for Developing a General Mathematics Course

It is doubtful whether any group of topics for a course in general mathematics could be collected by one individual or by a special group and still be acceptable to all other individuals or groups. However, there are several points with which all persons concerned with general mathematics could agree.

1. The liberal-arts students for whom the general mathematics course is designed should not be considered an inferior student. He should not be considered less capable because he is not interested in the traditional courses. He deserves the same attention from the mathematics department as do the students taking traditional mathematics. The general mathematics course should be worthy of the time the student spends on it. It should not be a "snap" course.

2. It should be recognized as always that each student must be accepted where he is although each may have a different background. The course in general mathematics should therefore be designed to redevelop and if necessary make provisions to develop initially the fundamental skills in mathematics. Thus the course may proceed on a firm footing as rapidly as possible to those concepts which bring about mathematical literacy.

3. Probably the principle with which there is most agreement is that every topic to be included should have applications understandable to the student.

For example, one of the areas considered essential in algebra and also essential for general mathematics is the understanding of variable relationships. The formula $d = rt$ is a simple example of a variable relationship. Aside from the basic condition that distance is dependent on rate and time of travel, this formula can be used to illustrate the effect on distance traveled during the reaction time of human beings. This information coupled with the braking distance of an

automobile (in itself a variable relationship) can find application in a contemporary problem—that of the terrific rate of automobile accidents which should be the concern of all people. If considered necessary and convenient this can be extended to the mathematics involved in the horsepower race in the automobile industry and the potential speed of automobiles with high horsepower.

Every person has occasion to read simple tables, graphs, and other devices commonly used to show statistical information. The interpretation of these statistical devices should always involve critical judgment and will often include the basic skills of arithmetic.

For instance, in a recently published textbook a table was presented to show the voting behavior in a certain community according to socio-economic status. In this table the residents were divided into five groups. Group one was composed of those individuals who were considered to have the highest income and the highest standard of living. The other groups were made up of other levels of income with the people with the lowest income considered group five. The voting record was shown for each group. It was shown for group one that 71% voted Republican and 29% voted Democratic. From this it was stated that those in the higher socio-economic status are more likely to vote Republican. With this there is no argument. However, a more thorough examination of the table showed that group one consisted of 52 people in a community of 1709 residents. Thus group one actually represented only about 3% of the total population. The 71% who voted Republican therefore represented approximately 2% of the total population. Thus critical judgment coupled with one of the basic skills of arithmetic can bring forth a more complete understanding of a table rather than just the one point of information presented in the title of the table.

The sine curve in trigonometry can be used to illustrate how mathematical concepts have found application in the development of our civilization. A discussion of the sine curve can show the difference between alternating current and direct current. This is practical information because it is important whether many modern electrical appliances are operated on Ac and/or Dc power. At the same time the difference between 60 cycle power in homes, 400 cycle power in aircraft, and 30 or 40 cycle power in some areas of the United States can be shown.

If it is considered desirable the treatment of the sine curve can include a discussion of amplitude modulation, frequency modulation, and the carrier wave in radio broadcasting. For a picture of the sine curve in "action" an oscilloscope can be connected to the speaker of a radio to see the effect on the carrier wave when music or a voice is superimposed on it.

Conclusions

Admittedly, the above examples are only a few of the many that could be used to illustrate the desirable concepts of a course in general mathematics. However, more important, they show applications that can be found and are at the level of the student and interesting to him.

Applications provide the transfer of mathematical concepts to problems not strictly mathematical. They are the means by which general mathematics can contribute to the general education of the student. The concepts of general mathematics should be as important to the objectives of general education as is effective communication.

ECONOMY IN ORDERING LABORATORY SUPPLIES

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One of the major tasks each year of the science instructor is to order supplies and equipment that will enable him to carry out a successful laboratory program. This task is ordinarily made more difficult by the fact that the money allowed is not completely adequate. This being the case, it is obvious that the teacher must spend the available funds carefully. Usually science supplies are ordered from one supply house that seems to provide the total material most economically. However, it has been suggested that savings might be made by "splitting" the order among several supply houses in order to effect economies in various kinds of items in which the respective companies may specialize.

Therefore it is the purpose of this paper to determine whether there is any appreciable difference between the cost of laboratory apparatus when ordered *in toto* from a general supply house of science materials, and when ordered, according to their specialties, from specialty supply companies.

The first step was to prepare a sample order of supplies that might be needed by a small high school. The next step was to categorize the order according to the areas of science to which the items might belong. Each category was similar to a "specialty" with which a specialty supply house might be chiefly concerned. The next step was to obtain catalogs of various companies and to prepare a general order and the corollary specialty orders. The quantity, description, and cost of each item, total cost of separate items, and the total cost of each order is included in this paper.

Company "A" is a general purpose supply company used for the complete order. Company "B" is the supplier of electronic equip-

ment. Company "C" is the supplier of general laboratory equipment. Company "D" is the supplier for chemicals. The comparison of costs follows:

Quantity	Description of item	Unit cost	Total cost
	COMPANY "A"		
1	demonstration slide rule	$ 13.50	$ 13.50
6	meter stick	.75	4.50
6	calorimeter, double walled	3.75	22.50
12	friction rod, glass	.80	9.60
12	friction rod, rubber	.45	5.40
12	silk pad	.65	7.80
12	cat skin, half	1.60	19.20
4	St. Louis motor	8.35	33.40
2	D.C. ammeter, ranges 30—3	19.50	39.00
2	A.C. ammeter, range 30	19.50	39.00
2	D.C. voltmeter, ranges 150—7	19.50	39.00
2	A.C. voltmeter, ranges 150—15	19.50	39.00
8	double convex lens, 10 cm	1.15	9.20
4	balances, triple beam	27.50	110.00
12	platinum needle	.50	6.00
8	thermometers, 110°C	1.94	15.52
2	microscope slides, $\frac{1}{2}$ gr. box	1.18	2.36
1	model of heart	29.75	29.75
1	model of eye	30.00	30.00
1	telephone transmitter	2.50	2.50
1	telephone receiver	3.00	3.00
10	petri dish, 150 mm	1.60	16.00
2#	acid acetic, glacial	1.37	2.74
6#	acid hydrochloric, C.P.	3.00	3.00
9#	acid sulfuric, C.P.	3.50	3.50
7#	acid nitric, C.P.	3.35	3.35
4#	ammonium hydroxide	2.50	2.50
6#	carbon tetrachloride	.45	2.70
6#	carbon disulfide	.60	3.60
1#	mercury	6.25	6.25
1	Handbook of Chemistry and Physics	8.50	8.50
4#	annunciator wire, no. 18 copper	1.75	7.00
1	battery substitute	31.75	31.75
	Total Cost		$571.02
	COMPANY "B"		
2	D.C. ammeter, range 30	$ 7.35	$ 14.70
2	A.C. ammeter, range 30	7.35	14.70
2	D.C. voltmeter, range 150	10.09	20.18
2	A.C. voltmeter, range 150	8.33	16.66
1	battery substitute	39.15	39.15
4#	annunciator wire, no. 18 copper	1.43	5.72
1	telephone transmitter	4.26	4.26
1	telephone receiver	6.00	6.00
	Total Cost		$121.37

Quantity	Description of item	Unit cost	Total cost
	COMPANY "C"		
1	demonstration slide rule	$ 18.00	$ 18.00
6	meter stick	.40	2.40
6	calorimeter, double walled	3.15	18.90
12	friction rod, glass	.50	6.00
12	friction rod, rubber	.35	4.20
12	silk pad	.50	6.00
12	cat skin, half	1.45	17.40
4	St. Louis motor	5.40	21.60
8	double convex lens, 10 cm.	2.10	16.80
4	balance, triple beam	39.00	156.00
12	platinum needle	.65	7.80
8	thermometer, 110°C.	1.35	10.80
2	microscope slides, ½ gr. box	1.20	2.40
1	model of heart	20.00	20.00
1	model of eye	22.50	22.50
10	petri dish, 150 mm.	1.24	12.40
1	Handbook of Chemistry and Physics	8.50	8.50
	Total Cost		$351.70
	COMPANY "D"		
2#	acid acetic, glacial	$ 1.37	$ 2.74
6#	acid hydrochloric, C.P.	2.75	2.75
9#	acid sulfuric, C.P.	2.85	2.85
7#	acid nitric, C.P.	2.95	2.95
4#	ammonium hydroxide, C.P.	1.95	1.95
6#	carbon tetrachloride	.38	2.28
6#	carbon disulfide	.50	3.00
1#	mercury	5.80	5.80
	Total Cost		$ 24.32
	Company "A"		$571.02
	Company "B"	$121.37	
	Company "C"	351.70	
	Company "D"	24.32	
	Total, specialty supply houses		497.39
	Difference, general supply—specialty houses		$ 73.63

Assuming the materials are of comparable quality, the difference of $73.63 seems to be a relatively large amount. As this is a relatively small order, it seems that the difference on a larger order would be quite substantial. As discounts are offered, in general, by the companies when larger quantities are ordered, it seems reasonable that even larger savings might be possible.

If more careful attention were made to a selection of suppliers and

a larger group of suppliers were considered, there might be a wider difference in the cost of materials. A similar order, but of larger scope, that is, a larger number of items and a greater number of suppliers considered, might show this to be the case or it might show this not to be the case.

It seems from the results of this paper, that more equipment may be purchased on the same budget if laboratory supply orders are split up, and material ordered from various companies that specialize in certain items rather than to order all supplies from the same company.

EASY DOES IT

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TO SHOW THE HEATING EFFECT OF AN ELECTRIC CIRCUIT IN SERIES AND PARALLEL CIRCUITS

Physics pupils may learn a great deal from apparatus that can be constructed from scraps found around a garage or junk yard. And the fact that the parts are simple prevents pupils from being overawed by more impressive and expensive apparatus.

A demonstration for showing the heating effects of an electric current in series and parallel circuits can be put together very easily. Select a wooden box the end of which is about 16 inches by 8 inches. Cut off the end of the box and cut out the inside of this end so that the edge is only about one inch wide, as shown in the rectangular shape in the figure. Mount two binding posts at each end so that they will be about two inches from the bottom and the top, as shown. Cut off 12 inches of number 18 copper wire and 12 inches of number 18 G.S. wire and connect horizontally, as shown. The apparatus should be made large enough so that every pupil in the classroom can see it. It should be set up vertically on the table. Any variation of the general pattern is satisfactory except that the two wires must be of the same gauge number and length, and of different material.

The two wires are connected, first, in series, and then in parallel, to one dry cell. The teacher makes the series connection before the class and has a pupil volunteer to come up to touch the two wires. The pupil is asked which of the two wires is the hotter. Then the teacher moves the outside wire terminal from A to B and connects a short wire between A and C. Again the pupil is asked which is the hotter. The pupil's reaction is very definite.

The fact that merely a slight change in a few connecting wires brings about opposite results catches the pupils' attention and

challenges their thinking. Pupils note that resistance is not the only factor that contributes to the heat developed and explanations from the group as a whole may be solicited.

Any "doubting Thomas" should be encouraged to come up and try the demonstration independently.

Precaution should be taken to keep the bare wire removed from the wooden structure.

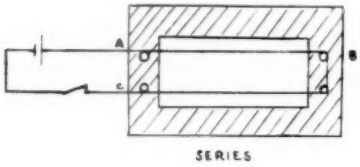

FIG. 1

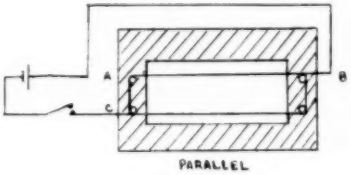

FIG. 2

ANOTHER EASY DOES IT

The same piece of apparatus the construction of which has already been described, can be used to demonstrate Oersted's experiment.

Set up the demonstration for the series circuit vertically to the table with its plane in the magnetic meridian, i.e., in the north-south direction as indicated by a magnetic compass. Place a pivoted light-weight magnet so that the magnet lies between the two parallel wires. The projection of the binding posts allows enough leeway for a small base for the mounting of the magnet. If there is no pivoted light-weight magnet about the laboratory, a magnet can be made from a long needle by the usual method of stroking with a larger magnet and the magnet thereby made is then suspended by a thread so that the magnet lies between the two wires on the board.

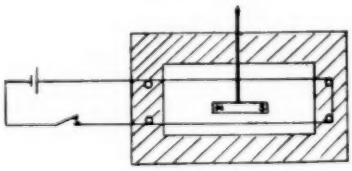

FIG. 3

A very light piece of red paper such as a cut-away edge of a red label stuck to the north pole of the magnet helps those pupils in the back of the classroom to see that the north pole moves in the opposite directions when the wires at the terminals to the dry cell are interchanged so that the direction of the current through the wires is reversed.

BIOLOGICAL SCIENCE FOR GENERAL EDUCATION

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In theory, at least, the course in biological science for general education should present the materials in such a way they will establish biological principles and the characteristics of living things useful to the student who does not plan on taking any more courses in this field. At the same time it should serve as an introductory course in biology for those who may desire other courses but not a major in the field. Such a course should also be directed toward showing man's place in and relation to the biological world. At the same time a close correlation with other subject materials and to the environment should be maintained to make the work most meaningful to the student.

In an attempt to accomplish these ends in our Principles of Biological Science (a three-quarter course) we approach the problem on the principle that living things differ from each other in degree and not essentially in kind and that all or most specializations, leading to the differences in the plants and among animals, have resulted in a better chance of survival. By this is meant that specializations in one form of life to care for the physiological needs have been of one or more kinds, and in another form the specialization has often been along another line. For example, in man the development caring for the function of irritability has resulted in a highly specialized nervous system. Accompanying this specialization the other systems have also become specialzed. In comparison with the nervous system of an insect or an earthworm the nervous system is more highly specialized and the work it can do in meeting man's need for adaptation or making it possible for him to survive is great. In plants irritability exists but the response is slower and no specialized nervous system can be demonstrated to be present. Reproduction can be traced (as may the other needs) through all stages from the simple to the complex. A balance between the needs and the specializations has led to the success or failure of each kind of plant or animal.

The classes are introduced to the characteristics or needs of all living things, such as metabolism, excretion, irritability, reproduction, etc. because these are usually common knowledge and can be rather easily understood. The structure of matter is discussed in its relation to chemical compounds and cell structure and the specialization of cells to form tissues, organs, and systems. The laws of conservation of energy and matter; cellular metabolism; differences and likenesses of plants and animals; and modes of nutrition are then taken up.

With these basic understandings the class should then be ready to study the different phyla of plants with their organization and specializations to meet the needs of living things and how these specializations have contributed to a better chance of survival as well as their importance to human welfare. Sexual reproduction in plants is traced to show its contribution to variety and the advantages of such variety in survival. The structure, life history, and ecology of each group thus becomes related to the fundamental needs of all living things.

The phyla of animals are studied in a like manner and the characteristic structure of the members of each phylum is studied in the light of its specializations to meet the needs of all living things and how these structures and functions compare with other forms of life.

The last part of the course is devoted to the study of man's structure and the relation of these structures to their functions; inheritance; principles of evolution; ecology; and the adaptations of living things are reviewed in relation to other living things. An attempt is made to list those things which are limited to *Homo sapiens* and to compare these with the other characteristics in which he differs from other forms of life only in degree.

We do not claim this is a new approach but the students, some of whom have had biology in high school, have commented favorably about it. They have stated that it gives coherence to the subject and meaning in intrepreting the biological world and man's place in it as well as meaning to the variety seen among living things.

SUN'S RAYS CHARGE BATTERY IN TRANSISTOR RADIO SET

Sunshine may provide the music for next summer's picnics, if the experimental sun-charged radio battery fulfills its promise of storing as well as utilizing solar energy.

A stand-by battery to furnish current when the sun is under a cloud can be charged during the hours when the sun is shining. A plastic strip attached to the top of the radio cabinet contains a battery of seven cells. In it the energy of the sun's rays is changed into electrical energy. This can be used either to power the radio set or to charge the stand-by battery.

Transistors take the place of electron tubes in this new style radio, taking the power from the sunshine with the help of a silicon element in the solar battery.

PEROXIDE BUBBLES HELP FIND ULCERS AND CANCER

Stomach ulcers and cancers that are hard to find by ordinary examinations may be detected with the help of hydrogen peroxide bubbles. Hydrogen peroxide bubbles when it comes in contact with an ulcerated surface, blood or pus. For detection of stomach ulcers, or cancer, the hydrogen peroxide is mixed with barium, a commonly used contrast medium for X-ray examination.

The patient swallows the mixture. The bubbling action, which will come in about 20 to 30 seconds, can be seen on the fluoroscope screen.

SCIENTIFIC ATTITUDES IN LANGUAGE ARTS

PAUL K. THOMPSON
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One objective of science education is the development of scientific attitudes. According to the National Society for the Study of Education (3), these are:

1. Open-mindedness—a willingness to consider new facts
2. Intellectual honesty—a scientific integrity and an unwillingness to compromise
3. Suspended judgment—scientific control, withholding of conclusions until all available data are in, and not generalizing from insufficient data.

The attitudes are probably best developed through the use of science content though their application may be to any field of endeavor. Language arts seems to be one of the areas which is suited to some direct attempts to help students develop scientific attitudes.

Students must learn to read and to listen critically, to be able to distinguish the relevant from the irrelevant, and to recognize opinion in the utterances of others. At the same time they should be able to analyze their own speaking and writing. They should form the habit of asking themselves as they report:

"Am I really telling what I know to be a fact or am I letting it be colored by my own bias or prejudice? Am I stating the facts as they are or am I stating only my inferences from the facts? Am I stating *all* the facts or am I leaving some out to 'slant' the picture in a certain direction? Am I stating only the facts or am I adding judgments of my own to the facts?"

This habit can probably best be developed through training in the distinction between reportive and non-reportive language. The science class seems to be a logical place for this type of training.

The following outline of the content and purposes of a unit on the differences between reportive and non-reportive language draws heavily from the works of semanticists S. I. Hayakawa (1) and Hugh Walpole (4).

Reportive language is that language which refers to objects or actions or situations which can be pointed to or described, and makes statements that can be verified or disproved by the other fellow. Examples of reportive language are:

John Jones was convicted for theft of an automobile.
You can get those at Smith's Hardware for $2.75.
There was an auto accident on the highway between here and Junction City.

Non-reportive language is any language that is not reportive in nature. Walpole calls it "emotive" language, that which expresses the speaker's feelings, aimed at stirring the feelings of the hearer, and

perhaps at spurring him on to some action. Some examples of non-reportive language, based on the above statements of facts are:

John Jones is a menace to our society.
You certainly don't know how to shop for hardware goods.
Something needs to be done about the inadequacies of our highway system.

Hayakawa lists those things to be excluded from reportive language as:

Inferences
Judgments
"Snarl-words" and "purr-words"
Slanting

An inference is a statement about the unknown made on the basis of the known. For example:

Inference: He thought a lot of himself.
Report: He never spoke to subordinates at work.

Inference: He was bashful.
Report: I saw him at a party and he never danced except when one of the girls asked him to.

A judgment is an expression of the writer's approval or disapproval of the occurrences, persons, or objects he is describing.

Judgment: It is a wonderful car.
Report: It has been driven over 75,000 miles without any major repairs.

Judgment: The senator is stubborn, defiant, and uncooperative.
Judgment: The senator has the courage to stand by his principles.
Report: The senator's vote was the only one against the bill.

Snarl-words and purr-words are what the Institute for Propaganda Analysis (2) calls "Name-Calling" and "Glittering Generalities." The practice of using snarl-words and purr-words consists of placing on an idea or a thing a label which in itself carries a connotation of goodness or badness. For example:

Snarl-word: He is certainly a namby-pamby fellow.
Purr-word: He is very obliging.
Report: Although he usually goes to the mountains for his vacation, he went to the beach this year after his wife asked him to.

Slanting is the practice of reporting only those facts which will make a situation appear as the writer or speaker would like for it to appear. Two directions of slanting are given in the example:

He had apparently not shaved for several days, and his face and hands were covered with grime. His shoes were torn, and his coat, which was several sizes too small for him, was spotted with dried clay.

or

Although his face was bearded and neglected, his eyes were clear and he looked straight ahead as he walked rapidly down the road. He looked very tall; perhaps the fact that his coat was too small for him emphasized that impression. He was carrying a book under his arm and a small terrier ran at his heels.

Exercises in the recognition of the four foregoing types of non-reportive language could be as follows:

Inferences: Give the students a list of reportive statements such as the following and ask them to make inferences based on each one.

The man was carrying his shoes in his hand as he entered the house.
The principal asked George to come to the office.
The Wilsons have bought a new car.

Give the students a list of inferences such as the following and ask them to write reportive statements upon which the inferences might have been based.

Susie is teacher's pet.
Billy's little brother doesn't like milk.
The soil around the school isn't very good.

Judgments: Ask the students to make judgments on the basis of statements similar to the following:

That teacher makes his pupils do extra work after school.
So far this year Mr. Harding has spent $50.00 on fishing trips and has brought home only three fish.
Bill drove from Eugene to Portland (125 miles) in two hours.

Ask the students to give reportive statements which might be bases for judgments such as the following:

Mary is a very sweet girl.
Jim didn't play fair with me in our dealings.
Mr. Andrews is the best science teacher in the school.

(Inferences and judgments are so similar in nature that they might better be lumped together under one heading and called statements of opinion.)

Snarl-words and purr-words: Make a list of snarl-words and purr-words such as the following and ask the students to mark −, 0 or + after the words indicating whether those words elicit a favorable response, no particular response at all, or an unfavorable response. Then ask the students to tell why those words elicited those responses. They will probably recognize the fact that it is only the label that arouses the response and not the thing for which the label stands.

Woman driver
"Duck-cut"
Teacher
Foreigner
Politician
Statesman
Socialism

Slanting: Practice in recognizing slanting in reports could probably best be given by having the students give slanted reports of their own. A picture might be shown, an incident enacted, or a situation read about, and then half the class asked to make the situation sound as

good as possible using only facts about the situation and the other half of the class asked to make it sound as bad as possible using only facts about the situation.

All of these aspects of non-reportive language may be found in newspaper articles and editorials (letters to the editor are especially good) and in advertisements. Students should have some practice in picking them out.

Walpole presents another approach to the distinction between reportive and non-reportive language with his four aspects of language which students may be asked to identify in various types of writing or speaking.

1. Sense—Does the information make sense on the basis of what is known? This is the principle factor in reportive language.
2. Feeling—Try to determine how the person speaking feels about the things he is discussing.
3. Tone—Try to determine the speaker's attitude toward the person to whom he is addressing himself. An example of this is: "It is with the deepest regret that we find it necessary to terminate your employment . . . etc.," instead of, "You're fired." (What was the real attitude of the speaker?)
4. Intention—Intention has its place in any form of utterance, whether it be social gossip, a novel, or a book on science. Its most obvious form is exemplified by the propagandist. A key to the intention of an utterance is often, who is behind it.

Practice in recognizing and using these various forms of reportive and non-reportive language should result in the students' ability to read more critically and therefore with more understanding. It should give him an appreciation for the need for accuracy in reporting and should strengthen his regard for and use of the scientific attitude through its use in a field other than science. It should develop a self-confidence in him as he finds himself better able to judge for himself what may be accepted and what should be suspect in his reading of reportive material.

Bibliography

1. Hayakawa, S. I., *Language in Thought and Action*, Harcourt Brace and Company, New York. 1949.
2. Lee, Alfred McClung and Lee, Elizabeth Bryant, *The Fine Art of Propaganda*, Harcourt Brace and Company, New York. 1939.
3. National Society for the Study of Education, *Science Education in American Schools*, 46th Yearbook, Part I. 1947.
4. Walpole, Hugh R., *Semantics: The Nature of Words and Their Meanings*, W. W. Norton and Company, Inc., New York, 1941.

SUN, OXYGEN, WATER, RUIN CAR FINISHES

When you wash your car after letting it stand in the beating sun, do not be surprised to find the color coming off on the rag. You have exposed your car to the three destructive forces that will eventually make its shiny, colorful finish rough and chalky—sunlight, oxygen and water.

MAGNETISM

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Chapter VII†

THE PROBLEM OF PAIRED DIPOLES

Fig. 72 showed the conditions favorable for finding the magnetic field at various points about a small magnet. Just as a matter of interest an actual demonstration of the conditions in Fig. 74 was set up as shown in Figs. 82 and 83. In Figs. 74, 82 and 83 the field about the dipole is shown in only one plane. It must be remembered that the field actually exists in three dimensions, for we are to consider *what happens inside of a large sphere filled with dipoles*, all of which we will think of as being paired and symmetrically placed about the center of the sphere.

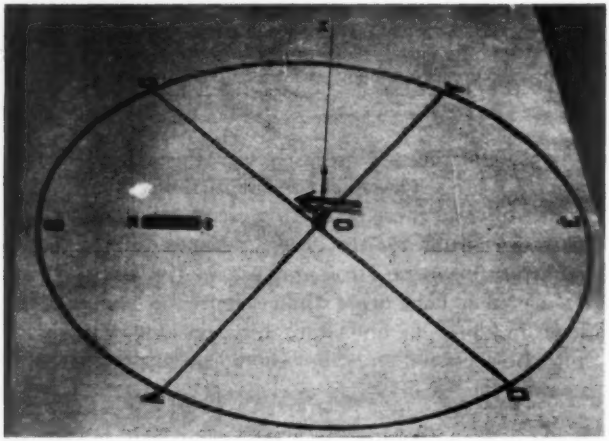


FIG. 82. The field about a magnet, N-S, as indicated by its effect on a magnetometer at *O*.

As one moves the magnet, *N*—*S*, (dipole) in Figs. 82 and 83 about the circle, *ABCD*, or into the various quadrants, the behavior of the bell-shaped magnetometer needle suspended at *O* by a fiber, indicates what is happening at the center of the sphere in which the dipoles are imbedded. With only one dipole, *N*—*S*, it is easy to see that a magnetometer needle turns in the direction of that part of the field of the dipole which happens to pass through *O*. In Figs. 82, 83 and 84 the magnets and the magnetometer needle at *O* are in a horizontal plane containing the axis of a Helmholtz coil about 3 feet in

* Deceased. Professor Williams died February 12, 1955.

† This will be the last chapter on "Magnetism" by Professor Williams.

diameter. This arrangment made it possible to eliminate the horizontal component of the earth's magnetic field.

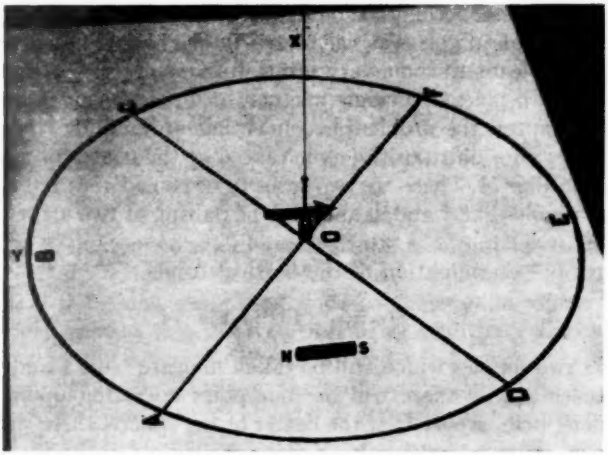


FIG. 83. The field about a magnet, N-S, as indicated by its effect on a magnetometer at *O*. Needle points in opposite direction to that in Fig. 82.

The effect of two dipoles, however, is quite different from a single one when they move symmetrically about the circle with their centers upon the circle and their axes parallel to the *Y* axis. Thus as the two dipoles, 1 and 2, in Fig. 74 move symmetrically abot *O* as drawn, their *X* components must annul each other, being oppositely directed. Consequently, as the centers of the two dipoles, 1 and 2, in Fig. 84 pass through the points, *A* and *C*, or *D* and *F*, the magnetometer needle at *O* suddenly turns through 180°. There is a critical angle θ_c, where $2\theta = \theta_c = \angle AOC$ at which this occurs, as can be proven by trial with the outfit shown in Fig. 84.

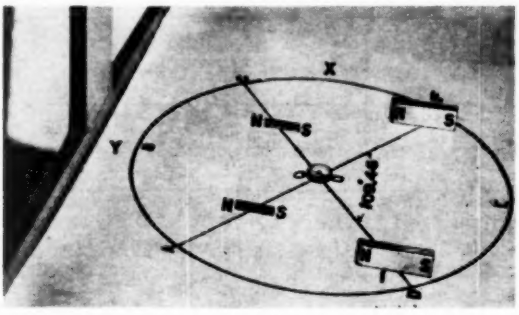


FIG. 84. Paired dipoles with centers symmetrical on the lines *CD* and *AF* produce zero field at *O*.

Calculation of the Resultant Magnetic Field Due to Paired Dipoles

This problem becomes a doubling of the one in which the field due to a single dipole was calculated in the preceding chapter. The calculation leads to some very interesting results. Instead of dealing with the two poles of a single magnet, or dipole, as given in the preceding chapter, the problem becomes that of handling the effects of four poles on a unit positive pole placed at the center of a sphere as shown in Fig. 74. There are two cases to be considered: I. The pairing of two dipoles like 1 and 2, and II. The pairing of two arranged like 2 and 4.

Case I. Determination of the Critical Angle,

$$2\theta = \theta_c = \angle 102 \text{ in Fig. } 74.$$

The two dipoles which will be taken first are Nos. 1 and 2 in Fig. 74. Inasmuch as there will be four poles operating upon the unit magnetic pole, $m' = +1$, at the center of the sphere, there will be four components to add along the X axis and four along the Y axis. These components are derived by using Coulomb's law for the forces between isolated magnetic poles. For convenience we will tabulate all eight of these forces participating in the problem, remembering that all four poles are equal and may be represented by the letter m. Care must be used in expressing the values of these individual forces that the proper signs are attached to them so they will be in harmony with the signs customarily assigned to the various quadrants used in geometry. F_2 and F_3 refer to the forces due to the two positive poles and F_1 and F_4 to the two negative ones.

Table I

Force	X Component	Y Component
$F_1 = \frac{m}{R_1^2}$	$-\frac{m \sin \theta_1}{R_1^2}$	$+\frac{m \cos \theta_1}{R_1^2}$
$F_2 = \frac{m}{R_2^2}$	$+\frac{m \sin \theta_2}{R_2^2}$	$-\frac{m \cos \theta_2}{R_2^2}$
$F_3 = \frac{m}{R_2^2}$	$-\frac{m \sin \theta_2}{R_2^2}$	$-\frac{m \cos \theta_2}{R_2^2}$
$F_4 = \frac{m}{R_1^2}$	$+\frac{m \sin \theta_1}{R_1^2}$	$+\frac{m \cos \theta_1}{R_1^2}$

It will be observed that when proper signs are given to the force components the total force along the X axis will be,

$$F_x = 0$$

in conformity with the experimental results already indicated.

Along the Y axis the total force will be,

$$F_y = (F_1 + F_4) - (F_2 + F_3)$$
$$= \frac{2m \cos \theta_1}{R_1^2} - \frac{2m \cos \theta_2}{R_2^2}$$

When this is evaluated we shall have the total resultant force acting upon $m' = +1$ at O, due to the dipoles, Nos, 1 and 2. This can be carried out in a fashion quite analogous to the way in which the equations on page 618 were derived. Again we shall have the same unknowns as we did on page 617 which need not be rewritten here but taken from that page. Putting the unknown values of θ_1, θ_2, R_1, and R_2 in terms of the known values of θ, R, and l, and substituting these quantities in the equation for F_y, we get the following form:

$$F_y = \frac{2mR_2^2 \cos \theta_1 - 2mR_1^2 \cos \theta_2}{R_1^2 R_2^2}$$

Naturally this value of F_y will be just twice that found for F_y in the preceding chapter and so we can at once write,

$$F_y = \frac{2M}{R^3} (3 \cos^2 \theta - 1)$$

An interpretation of this equation shows that the only condition under which $F_y = 0$ is when the quantity within the bracket becomes equal to zero, or

$$3 \cos^2 \theta - 1 = 0$$
$$\cos^2 \theta = 1/3$$
$$\cos \theta = \sqrt{1/3} = 0.57735$$
$$\theta = 54°44' = 54.733+ \text{ degrees}$$
$$\theta_c = 2\theta = 109°.466 \text{ degrees}$$

A pair of equal magnets placed symmetrically at A and C or at D and F will produce a zero field at O, the center of the sphere.

Case II. Determination of the Critical Angle,

$$2\phi = \phi_c = \angle 204 \text{ in Fig. 74.}$$

Of equal interest is it to see what effect the paired poles, Nos. 2 and 4, Fig. 74, will have on $m' = +1$ at O.

Again expressions may be written for the forces which the four poles exert on $m'=+1$. The various components will now be tabulated as was done for magnets 1 and 2.

TABLE II

Force	X Components	Y Components
$F_1=\frac{m}{R_1^2}$	$+\frac{m\cos\phi_1}{R_1^2}$	$+\frac{m\sin\phi_1}{R_1^2}$
$F_2=\frac{m}{R_2^2}$	$-\frac{m\cos\phi_2}{R_2^2}$	$-\frac{m\sin\phi_2}{R_2^2}$
$F_3=\frac{m}{R_2^2}$	$+\frac{m\cos\phi_2}{R_2^2}$	$-\frac{m\sin\phi_2}{R_2^2}$
$F_4=\frac{m}{R_1^2}$	$-\frac{m\cos\phi_1}{R_1^2}$	$+\frac{m\sin\phi_1}{R_1^2}$

Just as in the first case considered, so here, the sum of all of the components along the X axis is equal to zero, the total force along the X axis,

$$F_x=0$$

while along the Y axis,

$$F_y=\frac{2m\sin\phi_1}{R_1^2}-\frac{2m\sin\phi_2}{R_2^2}$$

$$=\frac{2m}{R^4}(R_2^2\sin\phi_1-R_1^2\sin 0_2)$$

$$=\frac{2m}{R^4}(R^2+Rl\sin\phi)\sin\phi_1+(R^2-Rl\sin\phi)\sin\phi_2.$$

$$=\frac{2m}{R^2}\left[R^2(\sin\phi_1-\sin\phi_2)+Rl\sin\phi(\sin\phi_1+\sin\phi_2)\right]$$

$$=\frac{2m}{R^4}\left[R^2(\sin\phi_1-\sin\phi_2)+2Rl\sin^2\phi\right].$$

Recalling the relations between the known and the unknown constants:

$$\sin \phi_1 - \sin \phi_2 = -\frac{l \cos^2 \phi}{R}$$

$$F_y = \frac{2m}{R^4}\left[R^2\left(-\frac{\cos^2 \phi}{R}\right) + 2Rl \sin^2 \phi\right]$$

$$= \frac{2m}{R^3}\left(-\frac{\cos^2 \phi}{R} + 2 \sin^2 \phi\right)$$

$$= \frac{2m}{R^3}(-1 + \sin^2 \phi + 2 \sin^2 \phi)$$

$$= \frac{2m}{R^3}(-1 + 3 \sin^2 \phi).$$

F_y will become zero under the condition that the quantity in parenthesis is equal to zero, or,

$$-1 + 3 \sin^2 \phi = 0$$

$$\sin^2 \phi = 1/3$$

$$\sin \phi = \sqrt{1/3}$$

$$= 0.57735$$

$$\phi = 35°16' = 35°.266$$

$$2\phi = \phi_c = 70°.532$$

It will be observed that ϕ is supplementary to θ_c.

The results obtained in Case I and now these obtained in Case II may be thought of as parts of a common picture in any plane drawn through the sphere and including the Y axis. It may be visualized more easily in a simple drawing like Fig. 85 than in a more complex one as in Fig. 74. The results of both Case I and Case II say that any two dipoles, which are alike, as they would be in a medium filled with like dipoles, when laid symmetrically with their centers on the lines AF or CD will produce zero effects at O so long as they are pointing in the same direction as H was originally applied, i.e., parallel to the Y axis. It is also to be kept in mind that this is true only for the condition that R is large with respect to l. By the same reasoning these results show that any dipole which lies within the solid spherical cones, $ABCO$ and $DEFO$, will have fields which at the point O have their components in the same direction as was H which oriented the dipoles originally. On the other hand, any dipole lying outside of these cones but still within the sphere $ABCFED$ will produce fields at the point O which are directed oppositely to that of the original H. These dipoles will lie within the circular band or belt about the

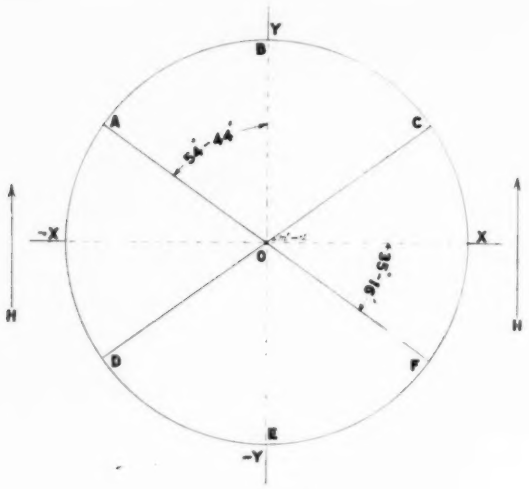


FIG. 85

sphere whose cross-section in Fig. 85 is represented by the triangles *AOD* and *COF*. It is the effect of all of these dipoles which produce the demagnetizing effect discussed on page 624. There are so many more dipoles lying within this belt about the sphere, than in the two solid cones, *ABCO* and *DEFO*, that as a result we have in the case of a sphere a large demagnetizing factor.

Some very interesting questions now arise about the distribution of the dipoles within the sphere of radius *R* which we have been considering. Suppose we had a sphere made of the alloy, Alnico, which is used today in making our most powerful permanent magnets. In the form of a sphere this alloy will still produce a strong spherical magnet, but its magnetic moment will be greatly reduced because the two poles are very close together. The question arises, What would happen to the magnetic moment of such a spherical magnet if all the dipoles which contribute to the demagnetizing factor were removed, viz., those dipoles which are in the belt around the equatorial section? It would be necessary to leave enough of the dipoles at *O* so that the two portions of the magnet would be held mechanically together. Under the same original magnetizing force, *H*, how would the external magnetic field of the dipoles left in the two solid cones, *ABCO* and *DEFO*, compare with those for the solid sphere intact? In order to check on this question, the following experiment was performed. Inasmuch as what occurs in the sphere, *ABCDEF*, Fig. 74, also occurs in any plane containing its axis, parallel to the direction of magnetization, one may take a sheet of ferromagnetic

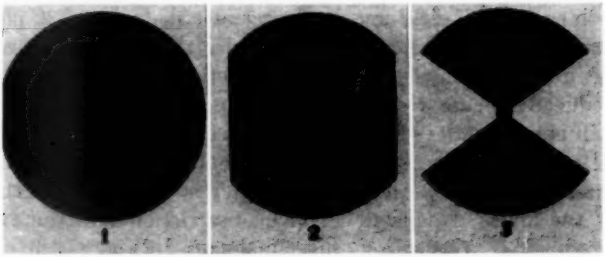


FIG. 86 1. Spherical magnet. 2 and 3. Magnets with part or all demagnetizing dipoles removed.

metal and cut it into three similar circular disks like No. 1 in Fig. 86. One of these disks was left as cut to represent the cross-section of a sphere. No. 2 has been cut along lines corresponding to those which might be drawn along *AD* and *CF* in Fig. 85. All of the dipoles in the two sections which were cut away contributed in part to the demagnetization factor. Finally in No. 3, Fig. 85, practically all portions of the circular disk have been cut away whose dipoles contributed to the demagnetization effect. Which one of these three will show the greatest external field strength at a common distance when all three are equally magnetized?

In Fig. 88 is shown a flat coil, *C*, wound from No. 30, *DCC* wire. The cross-section of this coil is a rectangle with a free space inside of the wooden bobbin on which the wire is wound, 0.5×4.0 cm, while the length of the coil is 8.2 cm. The axis of this coil is set normal to

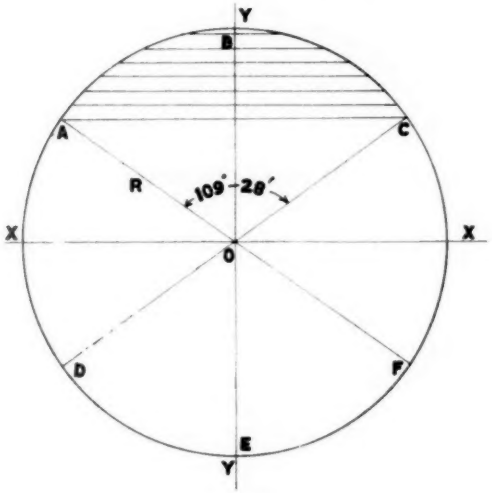


FIG. 87

the earth's magnetic field and its center at a distance of 20 cm from a magnetometer needle, M. When an electric current flows in the coil the magnetometer needle will be deflected. This deflection is then reduced to zero by means of the permanent magnet, *N*—*S*. When all is at rest the various shaped sheet magnets are inserted in the coil and due to the intensity of magnetization of the iron sheet magnets a deflection of the magnetometer occurs, wherein the tangent of the angle of deflection will be proportional to the external force produced by the various sheet magnets. In Fig. 87 the circular disk in dotted line is indicated as being in position inside of the coil. Care was taken to have the center of the sheet magnets at the center of the coil each time. The following readings (rough) are the average for a series of readings in which the sheet magnets were reversed for alternate readings. Also care was taken that these various shaped magnets were cut from the rolled sheet iron so that direction of rolling coincided with the direction of the magnetizing force. The average values for the three shapes were as follows:

No. 1	3.0
No. 2	2.6
No. 3	1.0

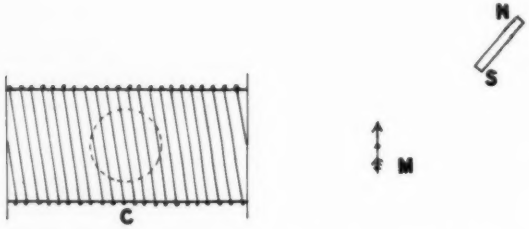


FIG. 88 Magnetizing coil *C*, magnetometer *M*, and neutralizing magnet, N-S.

From these readings it follows that the spherical magnet has roughly an external field three times as great as the one from which the demagnetizing portions had been removed. This simple experiment goes to show that the external magnetic field of the sphere is contributed by all of the dipoles which go to make up the magnet. Since the sphere has more dipoles it shows the larger external field.

It will now be of interest to compute the volume of the sphere, (a) wherein the uniformly distributed dipoles contribute to the imposed field, as in the two spherical cones, *ABCO* and *DEFO*, in Fig. 87, and (b) that part whose dipoles produce demagnetization at the center, found in the equatorial belt around the sphere, represented by the section *AXDO* and *CXFO* in Fig. 87.

In order to visualize just a little more concretely these two parts

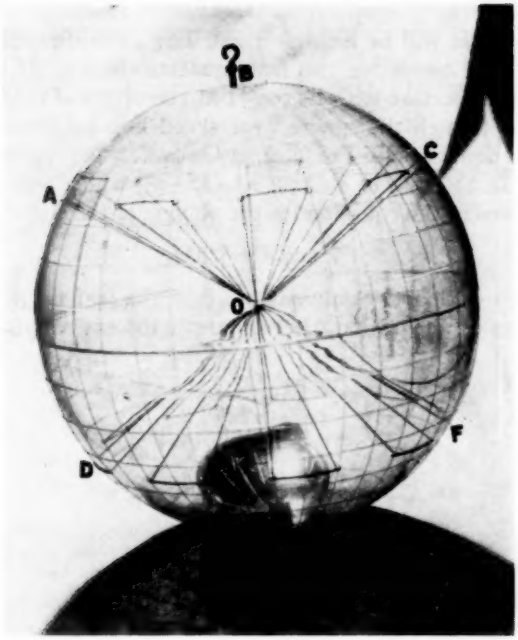


FIG. 89

of the sphere, there is shown in Fig. 89 a transparent spherical shell made of plastic. Through properly drilled holes, black thread has been drawn to show in 3-dimensional space those parts of the sphere which thus far have been described by 2-dimensional drawings. All of the dipoles in the two spherical cones, *ABCO* and *DEFO* are those which contribute to the field *H* at the center, *O*, of the sphere, while all of those dipoles in the equatorial belt around the sphere, indicated by *AOD* and *COF*, Fig. 89, have their paired resultants, acting in the opposite direction and give rise to the demagnetization factor which has been discussed.

It can be seen here also in Fig. 89 that if the dipoles in the belt, *AOD* and *COF* are removed that, for a given applied field, the field at *O* will be greatest when the angles of the spherical cones are each equal to 109°.466. It is for this reason that the poles of an electromagnet, as shown in Fig. 79, are tapered to this angle when it is desired to have a strong field at the center of the pole pieces.

Volume of the Two Spherical Cones, ABCO and DEFO, Fig. 87, Compared with the Total Volume of the Sphere

For the mathematical technique necessary to study this problem we need to use some simple calculus in finding these volumes. We

know the volume of a sphere is $V=4\pi R^3/3$. How did we arrive at such a value? It will be helpful in handling several problems which are to follow if we derive this last equation. In Fig. 87 is shown a sphere in cross-section with its center at the origin of coordinates. It is shown as though the sphere were sliced into infinitesimally thin wafers, dy units thick. For any given wafer the volume will be $V=\pi x^2 dy$. In the case of a circle, $x^2=R^2-y^2$, which value may now be substituted in the equation for the volume of the wafer,

$$V=\pi(R^2-y^2)dy$$

By adding together the volumes of all of the wafers, which we do by a process of integration, the volume of the entire sphere may be found.

$$\begin{aligned} V_s &= \pi \int_{-R}^{+R} (R^2-y^2)dy \\ &= \pi \int_{-R}^{+R} R^2 dy - \pi \int_{-R}^{+R} y^2 dy \\ &= \left[\pi R^2 y - \pi y^3/3\right]_{-R}^{+R} \\ &= (\pi R^3 - \pi R^3/3) - (-\pi R^3 + \pi R^3/3) \\ &= 2\pi R^3 = 2\pi R^3/3 = \frac{6\pi R^3 - 2\pi R^3}{3} \\ &= 4\pi R^3/3 \ Q.E.D. \end{aligned}$$

By an entirely analogous procedure the volumes of the two solid cones will next be determined. It will be easier to do this in two steps as shown in Fig. 87. 1. Find the volume of the plane cone, AOC, and 2, Find the volume of the segment, ABC.

1. Volume of the cone AOC.—From elementary Geometry we know the volume of a cone is equal to the area of the base multiplied by $\frac{1}{3}$ of its vertical height. From Fig. 87 it may be seen that the area of the base is $\pi R \sin^2\theta$ and the height is $R\cos\theta$. Hence the volume of the cone is,

$$V_c=(\pi R^2 \sin^2\theta)(R\cos\theta)/3$$

Let us see how this equation is derived by calculus.

Again the cone and the segment may be thought of as being sliced into thin wafers and the volume of each one is, as for the sphere, $\pi x^2 dy$. For the plane cone, AOC, the side is a straight line, so that $x=my$, which is then substituted in the volume of the single wafer,

$\pi m^2 y^2 dy$. Summing up the volumes of all of the wavers in the cone, AOC, we get the total volume,

$$V_c = \pi \int_0^{R\cos\theta} m^2 y^2 dy = \left[\pi m^2 y^3/3\right]_0^{R\cos\theta}$$

$$= \frac{\pi m^2 R^3 \cos^3\theta}{3} \quad \text{where} \quad m = \sin\theta/\cos\theta$$

$$= \frac{\pi \sin^2\theta R^2 \cos^3\theta}{3\cos^2\theta}$$

$$= \frac{(\pi R^2 \sin^2\theta)(R\cos\theta)}{3} \quad Q.E.D.$$

2. *Volume of the Segment, ABC, (Fig. 87).* Again the volume of any wafer is,

$$\pi x^2 dy = \pi(R^2 - y^2)dy$$

Summing up the volumes of the wafers for this segment we get,

$$V_s = \pi \int_{R\cos\theta}^{R} (R^2 - y^2)dy = \pi \int_{R\cos\theta}^{R} R^2 dy - \pi \int_{R\cos\theta}^{R} y^2 dy$$

$$= \left[\pi R^2 y - \pi y^3/3\right]_{R\cos\theta}^{R} = \pi R^3 - \pi R^3/3 - \pi R^3 \cos\theta + \pi R^3 \cos^3\theta/3$$

$$= \frac{3\pi R^3 - \pi R^3}{3} - \frac{3\pi R^3 \cos\theta - \pi R^3 \cos^3\theta}{3}$$

$$= \frac{\pi R^3}{3}\left[2 - \cos\theta(2 + \sin^2\theta)\right]$$

$$= \frac{\pi R^3}{3}\left[2(1-\cos\theta) - \cos\theta \sin^2\theta\right]$$

(3) Total Volume of Cone and Segment, Fig. 87

$$V_t = V_c + V_s$$

$$= \frac{\pi R^3}{3}\left[2(1-\cos\theta) - \cos\theta \sin^2\theta + \cos\theta \sin^2\theta\right]$$

$$= \frac{2\pi R^3}{3}\left[1 - \cos\theta\right]$$

Inasmuch as there are two cones. $ABCO$ and $DEFO$, the volume of the two will be,

$$V_e = \frac{4\pi R^3}{3}(1 - \cos\theta)$$

The total volume of the sphere as given above is $v = 4\pi R^3/3$, hence the ratio, Z, of the volume of the two spherical cones to that of the total sphere will be,

$$Z = \frac{\frac{4\pi R^2}{3}(1-\cos\theta)}{4\pi R^3/3} = 1-\cos\theta$$

Putting in this equation the value $\theta = 54° - 44'$

$$Z = 1-\cos\,(54° - 44')$$
$$= 1-0.57738 = 0.42262$$

This means that out of the total volume of the sphere, 0.42262 part of it is occupied by the two spherical cones and 0.57738 part is occupied by the belt around the sphere. There are more dipoles contributing to the demagnetizing force at the center with some fraction of

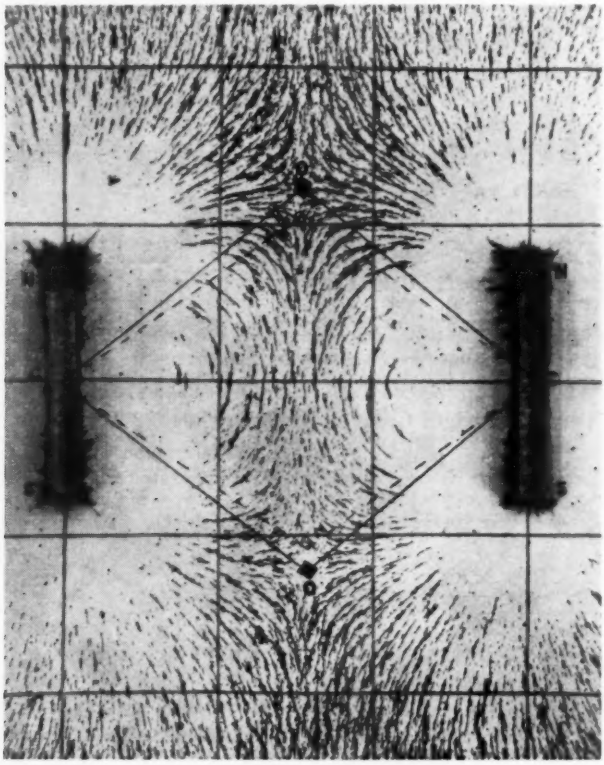


FIG. 90

their total field than there are of those contributing to the field in the direction of H.

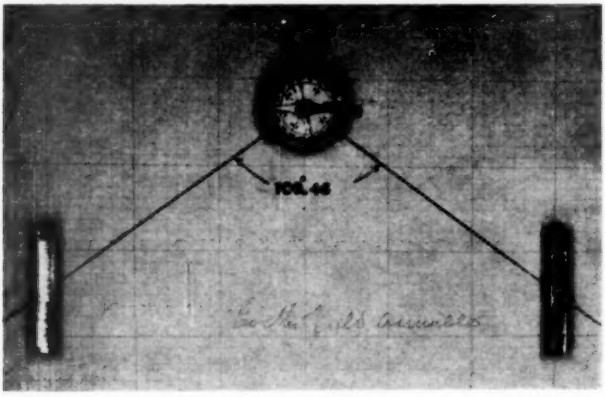


FIG. 91

Experimental Verification of the Critical Angles, $\theta_c = 109°.466$ and $\phi_c = 70°.532$

The magnets, 1, 2, 3, and 4, Fig. 74, are symmetrically placed about the axes X and Y. This means that in any plane through the sphere which includes the Y-axis we can experiment in a plane and show some of the relationships which have been discussed in deriving the critical angles, θ_c and ϕ_c. The easiest way to demonstrate that at O there is a zero field intensity due to the paired dipoles shown in Fig. 74 is to place the centers of two equal magnets which have been drawn with an angle of 109.466 degrees between them as indicated in Fig. 90. When the axes of the two dipoles are arranged parallel and symmetrically over these two lines lines as shown, scatter iron filings all around the magnets and the filings will arrange themselves in the pattern shown. If the distances OC are large with respect to the length of the magnets then the two neutral points in the magnetic field will come exactly at the intersection of the two lines. This matter of relative lengths is brought out in Fig. 90 where OC is commensurable with the length of the magnet and the angles at O is not 109.466 degrees. The dotted lines show this value. Fig. 91 shows the distance OC much longer with respect to the length of the magnets. If the magnets shown in Fig. 90 were a steel cylinder and magnetized in the same direction the points at the two O's would still be neutral points.

In place of iron filings one may place at the intersection of the two lines a magnetometer needle to show that the two magnets do not

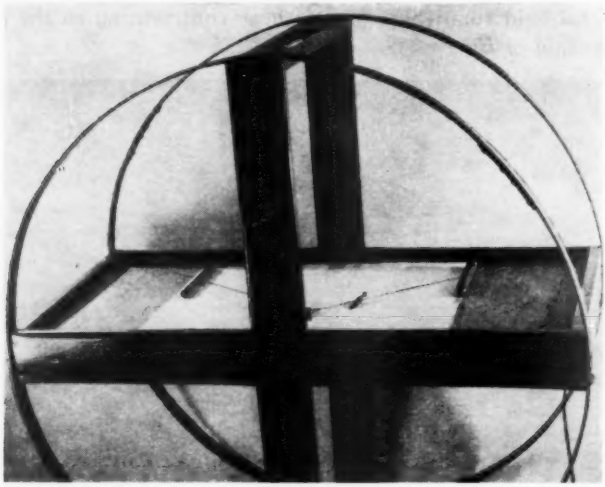


FIG. 92

have any resultant directive couple acting at the points O. This arrangement is shown in Fig. 91.

It is also much better to work in a space free from the earth's magnetic field. In Fig. 92 is shown a Helmholtz coil set with its axis so as to annul the north and south horizontal components of the earth's magnetic field. Both Figs. 84 and 92 show two different sized magnets placed symmetrically along the lines converging at O. Not only experimentally but also from an interpretation of the equations it follows that the angle θ is independent of the size of the magnets used, i.e., independent of the value of the magnetic moment M. This

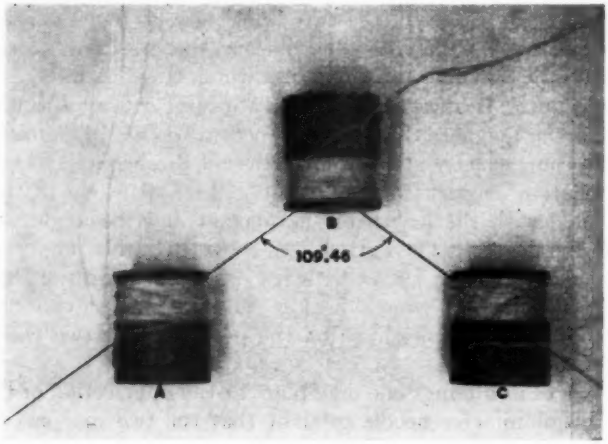


FIG. 93

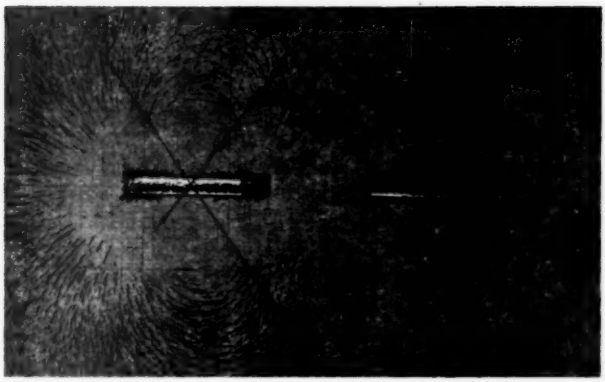


FIG. 94

holds for magnetons as well as for the large magnets shown in the various figures.

It goes without saying that the two magnets in Fig. 91 could be replaced by two coils, *A* and *C*, as in Fig. 93. By connecting a third coil *B*, to a telephone receiver the buzz from a rapidly alternating current flowing in the two coils, *A* and *C*, Fig. 93 in series may be picked up by the circuit containing *B*. When the center of the coil *B* finally comes to the point of intersection of the two lines whose angle between them is 109°.466 the buzz becomes zero.

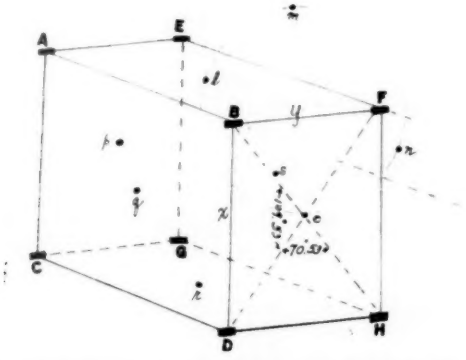


FIG. 95. Arrangement of an octet of dipoles in a medium uniformly filled with dipoles. The points *l*, *m*, *n*, *o*, *p*, *q*, *r*, and *s* are points where the magnetic fields due to the octet result in zero field strength.

In a similar fashion we can demonstrate that $\phi_c = 70°.532$ for the magnets, 2 and 4, in Fig. 74. Only one demonstration, Fig. 94, is shown for this set of paired dipoles. In this case there will be a ring of zero field values about the axis running parallel to the axes of the two dipoles.

TERMITES IN THE CLASSROOM

JAMES EDGAR HYER
Culp Creek School, Culp Creek, Oregon

When several dozen termites arrived in the classroom one morning, someone immediately remembered seeing pictures of them in a science booklet. After a period of observation, booklets were taken from the shelves and at least one boy was observed reading more willingly than usual. Most of the class became so enthusiastic about the termites, they could hardly wait for a group discussion. Their enthusiasm was catching; I soon found myself reading to get more information.

Some students found additional material on termites in encyclopedias and other reference books. Encyclopedias from other rooms found their way into ours, and with interest so high in reading about and observing termites, it was difficult to lead the class into an orderly discussion. A few boys who had read longer than I had expected them to, had discovered, much to their delight, that termites and ants will fight, and that frogs will eat termites. They had been experimenting while others continued to read.

One boy found a large black ant which he put into a jar lid with a soldier termite. The ant killed the termite in a short time, but not before staging a battle that thrilled an excited youngster. Another boy who had a pet frog in a home-made terrarium, put several termites in with the frog and discovered that the frog would eat them. After discussing these simple experiments, the class decided to repeat them. From the enthusiasm shown for the ant-termite battle it wasn't surprising to hear that the battle was repeated many times later. Partiality was shown for termites however; it became an accepted practice to have several termites battle with one ant.

Our discussion brought out much interesting information about termites, most of it new to teacher as well as students. Some information was unique and doubtfully accepted by some of the children. For example—

Some types of termites are known to have very small animals, called protozoans, living in their alimentary canals which digest the wood that termites eat and make sugar that termites use as food. These termites would starve if the protozoans died and they could get no others. Worker termites regurgitate protozoans into the mouths of the young.

Soldier termites are unable to eat by themselves. Their large heads and jaws are only good for fighting, as when defending the nest. The workers chew up the wood and feed them.

If the colony loses a king or queen, sterile but sexed workers develop into reproductives. The king and queen are believed to produce hormones that are licked off by workers which cause them to remain undeveloped.

Termites are believed to never die of old age, although they are often destroyed or eaten by other animals.

Other information we acquired, explained differences in termites from various parts of the world which was referred to by students when studying geography. Interest in types of termites that build peculiar nests in South America, motivated further reading about South America.

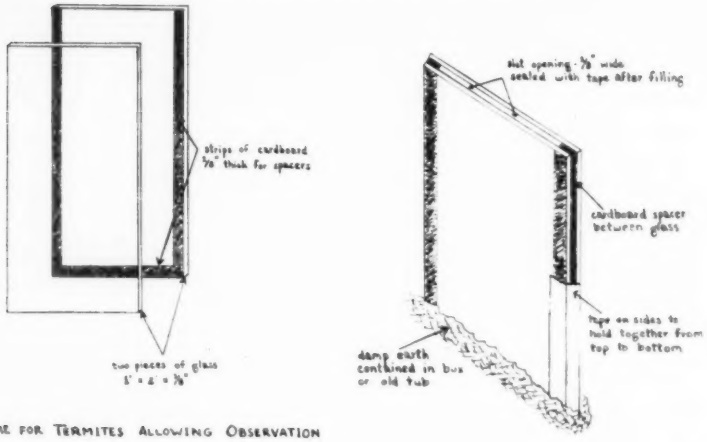
After the first general discussion on termites, the students wished to write stories, a favorite activity when studying something interesting. They took pride in their compositions especially when one was selected by the class to be read in other rooms as a sample of sixth grade work.

After discussing the possible damage termites could cause in our community, some youngsters discovered termites in an old deserted building. Others talked about termites getting into the "cold deck," a stack of logs kept on hand by the local sawmills. Our field trips disclosed termites in rotten logs on the ground and in old fence posts, but none were found in telephone poles which were creosoted. Interest in an encyclopedia statement saying that the annual loss from termites amounted to forty million dollars a year in the United States, resulted in an attempt to learn how some termite damage can be avoided. Creosoted wood and concrete foundations were discussed.

Some members of the class were interested in discovering how we could watch the workers feed the soldiers and groom the king and queen. All of us wondered if some of the workers were developing into reproductives. Having anticipated these possible developments, I had located directions for building a termite home which would allow observation of their activities.*

Placing two panes of glass together, each piece about a foot by two foot in diameter, we inserted cardboard spacers around the edge between the glass which held the panes about one eighth of an inch apart. Adhesive tape was used to bind the edges together, leaving only a cardboard spacer at the bottom and an opening of one eighth of an inch across the top. We dropped small particles of damp decayed wood between the panes of glass and tamped with stiff cardboard until the space was one-third or one-half filled. The termites were then put in the space and damp wood was added until the space was almost full. Considerable caution not to injure the termites was necessary because the damp wood must be tamped to eliminate air pockets. The top was filled with more decayed wood and some fine, old and dampened sawdust before sealing with tape. Some small pin holes were made in the top binding, and the bottom of the glass cage was buried in a box of damp earth. Termites cover the glass with a secre-

* ————, *Science in the Elementary School*, California State Department of Education, 1945.



HOME FOR TERMITES ALLOWING OBSERVATION

tion when exposed to light for long periods of time, so it was necessary to cover the glass with a black cloth when they were not being observed by the children.

In a few days the termites had some organization. Tunnels were under construction, rooms were present, and all of the live termites were industriously working near the center of the cage. The children spent hours watching them during recess and before school as well as during free time in the classroom. Eventually they were rewarded because they found two termites growing larger. These were presumed to be reproductives. We were never sure that we saw the feeding and the grooming of the king or queen by the workers. When the black cloth was removed for observation, the termites seemed to be bothered by the light and apparently did not carry on normal activities.

During the remainder of the year, many children from other rooms came to observe termite activities. It became evident that the study of termites was very interesting to most of them.

DEVELOP RADIOACTIVE MEANS TO STUDY HEART'S ACTIVITY

A new radioactive technique for determining the chemical activity of the heart muscle has been developed at Tulane University.

Relations between chemical activity and heart disease such as coronary thrombosis may eventually be studied through this new technique. With its aid, it is also hoped much more can be learned about the effects of various drugs on the heart.

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING
Harris Teachers College, St. Louis Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, Harris Teachers College, St. Louis, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1458, 2456. *N. Kailasamaiyer, Madras, India.*

2471. *Margaret LaBoyteaux, Paris, France.*

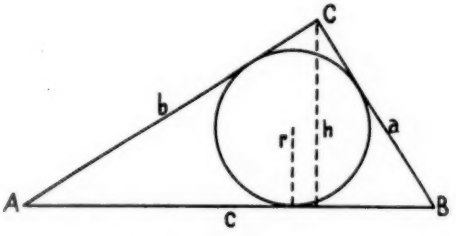
2471. *Miss P. Maude Hermes, Waterloo, N. Y.*

2465. *Martha Hoagland, Covert, N. Y.*

2473. *Proposed by C. H. Butler, Kalamazoo, Michigan.*

Prove that in any triangle, the radius of the inscribed circle is to the difference between that radius and the altitude drawn to a given side as the sine of half the angle opposite the given side is to the cosine of half the difference of the other two angles.

Solution by the proposer



Let c be the given side in the triangle shown here.

$$\tfrac{1}{2}ch=\tfrac{1}{2}r(a+b+c)$$

since each of these correctly expresses the area of triangle ABC

$$\therefore \quad \frac{h}{r}=\frac{a+b+c}{c}=\frac{a+b}{c}+1$$

$$\therefore \quad \frac{h}{r}-1=\frac{a+b}{c}$$

$$\therefore \quad \frac{h-r}{r}=\frac{a+b}{c}$$

$$\therefore \quad \frac{r}{h-r}=\frac{c}{a+b}$$

But

$$\frac{c}{a+b}=\frac{\sin \frac{1}{2}C}{\cos \frac{1}{2}(B-A)}$$

since this is one form of the well-known Mollweide's equations

$$\therefore \quad \frac{r}{h-r}=\frac{\sin \frac{1}{2}C}{\cos \frac{1}{2}(B-A)}$$

Solutions were also offered by Millard E. Agerton, Preston, Ga.; Richard H. Bates, Milford, N. Y.; Herta T. Freitag, Roanoke, Va.; A. R. Haynes, Tacoma, Wash.; Felix John, Philadelphia, Pa.; A. MacNeish, Chicago, Ill.; Frances Moore, East Varick, N. Y.; C. W. Trigg, Los Angeles, Calif.; James F. Ulrich, Arlington Hts., Ill.; Mrs Walter Warne, St. Petersburg, Fla.; and H. Wolf, Chicago, Ill.

2474. *No correct solution has been offered.*

2475. *Proposed by Louis J. Hall, Bloomington, Ind.*

A man cashed a certain check; however the teller became confused and interchanged the dollars and cents giving him the same number of dollars as was cents on the check, and the same number of cents as was dollars on the check. The man then spent \$9.32 and discovered he had twice the amount of the check. What was the original amount of the check?

Solution by Richard H. Bates, Milford, N. Y.

Let d = the number of dollars in the original check, and c = the number of cents in the original check. Then:

$$100c+d-932=2(100d+c) \quad \text{omitting decimal points}$$

$$100c+d-932=200d+2c$$

$$98c=199d+932$$

$$c=\frac{199d+932}{98}$$

Searching for values of d which will make c integral, the smallest value of d is 16 and c becomes 42.

Hence the amount of the original check was \$16.42.

Solutions were also offered by Robert A. Atkins, Brooklyn, N. Y.; Charles H. Butler, Kalamazoo, Mich.; Millard E. Agerton, Preston, Ga.; Gerald Doeden, Valparaiso, Ind., Herta Taussig Freitag, Roanoke, Va.; A. R. Haynes, Tacoma, Wash.; Felix John, Philadelphia, Pa.; Margaret Joseph, Milwaukee, Wis.; J. H. Means, Austin, Texas; A. MacNeish, Chicago, Ill.; Eugene F. Patrone, Brooklyn, N. Y.; Oliver T. Shannon, Pine Bluff, Ark.; C. W. Trigg, Los Angeles, Calif.; J. J. Wickham, Yonkers-on-Hudson, N. Y.; and the proposer.

2476. *Proposed by Julius S. Miller, New Orleans, La.*

If a projectile were fired in a horizontal direction from a high cliff with a velocity such that, as it advanced one mile it would drop just enough to follow

the curvature of the earth, it would, neglecting air resistance, continue around the earth with undiminished velocity, and therefore go on forever! If the earth "drops away" 8 inches per mile, find the velocity required.

Solution by Robert A. Atkins, Brooklyn, N. Y.

Any projectile is subject to the pull of gravity as it travels through the air. It gives a downward acceleration of approximately 32 feet/sec/sec. to any projectile, no matter what its horizontal velocity. To find out how long it would take this (or any) projectile to "fall" 8 inches ($\frac{2}{3}$ of a foot) we use the formula

$$s=\frac{1}{2}gt^2$$

where $g=32$ ft/sec/sec

$$\frac{2}{3}=16t^2$$

$$2=48t^2$$

$$t^2=\frac{1}{24}$$

$$t=\frac{1}{\sqrt{24}}\text{ sec.}$$

The projectile travels one mile during this time. To find the muzzle velocity in feet per second, we can use the proportion:

$$\frac{520\text{ ft.}}{\frac{1}{\sqrt{24}}\text{ sec.}}=\frac{x\text{ ft.}}{1\text{ sec.}}$$

The muzzle velocity (x) turns out to be 5280 ($\sqrt{24}$) which is approximately 25,867 feet per second or about 17,636 miles per hour!

Solutions were also offered by Millard E. Agerton, Preston, Ga.; Charles H. Butler, Kalamazoo, Mich.; Gerald E. Doeden, Valparaiso, Ind.; A. R. Haynes, Tacoma, Wash.; Alan Wayne, Baldwin, N. Y.; and the proposer.

2477. *Proposed by Hugo Brandt, Chicago, Ill.*

Given

$$A(3x^3+1)+B(2x^2+1)=17(10x+1).$$

Find A and B in terms of x to satisfy the equation for all values of x.

Solution by C. W. Trigg, Los Angeles City College

Let $A=Cx+D$ and $B=Ex^2+Fx+G$, thus

$$(Cx+D)(3x^3+1)+(Ex^2+Fx+G)(2x^2+1)-17(10x+1)=0.$$

Now if this equation holds for all x, the coefficients of each power of x must vanish. So

$$3C+2E=0, \qquad C+F-170=0,$$
$$3D+2F=0, \qquad D+G-17=0,$$
$$E+2G=0,$$

The solution of this set of simultaneous equations is

$$C=92, \quad D=-52, \quad E=-138, \quad F=78, \quad G=69.$$

Therefore,

$$A=92x-52 \quad \text{and} \quad B=-138x^2+78x+69.$$

Solutions were also offered by Millard E. Agerton, Preston, Ga.; and the proposer.

2478. *Proposed by Oscar W. Reid, Rogers, Ark.*

Find the positive number x so that $4^8+4^{11}+4^x$ shall be a perfect square.

Solution by Howard George Lange, Chicago, Ill.

$$4^8+4^{11}+4^x=2^{16}+2^{22}+2^{2x}.$$

If we make the expression a perfect trinomial square, the product of the square roots of the first and last term doubled must equal the middle term.

Hence

$$2^8 \cdot 2^x \cdot 2=2^{22}$$
$$2^{x+9}=2^{22}$$

and

$$x+9=22$$
$$x=13.$$

If we rearrange terms and proceed as before

$$2^{11} \cdot 2^x \cdot 2=2^{16}$$
$$2^{x+12}=2^{16}$$

and

$$x+12=16$$
$$x=4.$$

And again.

$$2^{11} \cdot 2^8 \cdot 2=2^{2x}$$
$$2^{20}=2^{2x}$$

and

$$20=2x,$$
$$x=10.$$

Solutions were also offered by Richard H. Bates, Milford, N. Y.; Charles H. Butler, Kalamazoo, Mich.; Daniel Finkel, Brooklyn, N. Y.; A. R. Haynes, Tacoma, Wash.; Felix John, Philadelphia, Pa.; Willie B. Porter, New Iberia, La.; J. H. Means, Austin, Texas; and C. W. Trigg, Los Angeles, Calif.

EDITOR'S NOTE: Mr. Lange is a student at Lane Technical High School, Chicago, Ill. It is of interest to note that all of the solutions submitted the above is the only one that found all of the solutions.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

For this issue the Honor Roll appears below.

2473. *Keith Kindig, Santa Monica, Calif.*

2473, 2474, 2475. *Lee Dresden Goldberg, Hillside, N. J.*

2476, 2478. *Howard George Lange, Chicago, Ill.*

2478. *Sheldon L. Epstein, Chicago, Ill.*

PROBLEMS FOR SOLUTION

2497. *Proposed by Brother Felix John, Philadelphia, Pa.*

A number of $2n$ digits is divisible by 11. How many permutations of this number are also divisible by 11?

2498. *Proposed by Nathan Altshill-Court, University of Oklahoma.*

AB, CD, and AD, BC are the two pairs of opposite sides of a parallelogram, and A', B', C', D', are the midpoints of the lines joining the vertices, A, B, C, D, to a given point M. Show that the four lines AC', BD', CA', DB' intersect each other in the same point.

2499. *Proposed by O. F. McCrary, Raleigh, N. C.*

Three boys having 10, 30, and 50 apples respectively visit a city and sell them at the same rate, and receive the same amount for them. How much do they receive for the apples, and what rate do they sell them?

2500. *Proposed by Leon Bankoff, Los Angeles, Calif.*

A point R is chosen on side AD of square $ABCD$ and a circle, O, is described on diameter AR. Extend BR and CD to meet in S and draw the line segment OS cutting O in T. Show that $ST = SD$.

2501. *Proposed by Charles H. Butler, Kalamazoo, Mich.*

Given a right regular pyramid of n faces, with lateral edges t units long and base edges b units long. Find an expression in terms of n, t, and b for the common measure of the dihedral angles at the base.

2502. *Proposed by A. H. Haynes, Tacoma, Wash.*

If the sides of triangles ABC are

$$a_i x + b_i y + c_i = 0 \qquad (i = 1, 2, 3)$$

then show that

$$\text{area} = \tfrac{1}{2}[a_1 b_2 c_3]^2 / [a_1 b_2][a_1 b_3][a_2 b_3]$$

where the determinants are represented by enclosing their principal terms in brackets.

BOOKS AND PAMPHLETS RECEIVED

BASIC MATHEMATICS FOR SCIENCE AND ENGINEERING, by The Late Paul G. Andres, *Illinois Institute of Technology;* Hugh J. Miser, *Operations Analyst, United States Air Force;* and Haim Reingold, *Illinois Institute of Technology*. Cloth. Pages vii+846. 14.5×23 cm. 1955. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.75.

GAS TURBINES AND JET PROPULSION, by G. Geoffrey Smith, M. B. E. Sixth Edition revised and enlarged by F. C. Sheffield. Cloth. 412 pages. 13×21.5 cm. 1955. Philosophical Library, 15 East 40th Street, New York 16, N. Y. Price $15.00.

COLLEGE ALGEBRA AND TRIGONOMETRY, A BASIC INTEGRATED COURSE, by Frederic H. Miller, *Professor of Mathematics, The Cooper Union School of Engineering*. Second Edition. Cloth. Pages xiv+342. 13.5×21.5 cm. 1955. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

SCIENCE FOR YOUR NEEDS, by Maurice U. Ames, *Principal, Frank D. Whalen Junior High School, New York City;* Arthur O. Baker, *Directing Supervisor of Science, Cleveland Board of Education;* and Joseph F. Leahy, *Science Instructor, Herrick Junior High School, Cleveland, Ohio.* Cloth. 364 pages. 17.5×23 cm. 1956. Prentice-Hall, Inc., Englewood Cliffs, N. J. Price $3.48.

ATOMIC ENERGY RESEARCH AT HARWELL, by K. E. B. Jay. Cloth. Pages xii+144. 13.5×21.5 cm. 1955. Philosophical Library, 15 East 40th Street, New York 16, N. Y. Price $4.75.

THE BEQUEST OF THE GREEKS, by Tobias Dantzig. Cloth. 191 pages. 13.5×21 cm. 1955. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y. Price $395.

THE SHIP—HOW SHE WORKS, by Stuart E. Beck. Cloth. 71 pages. 18×25 cm. 1955. John de Graff, Inc., 64 West 23rd Street, New York 10, N. Y. Price $2.75.

SHOP MATHEMATICS, by Claude E. Stout, *Chairman, Department of Mathematics and Engineering Mechanics, General Motors Institute, Flint, Michigan.* Cloth. Pages xi+282. 13.5×21.5 cm. 1955. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.70.

DICTIONARY OF NEW WORDS, by Mary Reifer. Cloth. Pages ix+234. 13.5×21 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York, N. Y. Price $6.00.

REFLECTIONS OF A PHYSICIST, by P. W. Bridgman. Second Edition, enlarged. Cloth. Pages xiv+576. 13.5×21 cm. 1955. Philosophical Library, Inc., 15 East, 40th Street, New York. Price $6.00.

CLASSICS OF BIOLOGY, by August Pi Suner. Cloth. Pages x+337. 13.5×21.5 cm. Philosophical Library, Inc., 15 East 40th Street, New York, N. Y. Price $7.50.

THE BARD OF GREENBUSH (SAMUEL WOODWORTH 1784–1842), by William Gould Vinal, *Professor Emeritus, Nature Education, University of Massachusetts at Amherst.* Paper. 20 pages. 15×23 cm. 1955. William G. Vinal, R.F.D., Vinehall, Norwell, Mass. Price 50 cents.

STATISTICAL SUMMARY OF EDUCATION 1951–52, prepared by Rose Marie Smith. Paper. Pages x+65. 14.5×23 cm. 1955. Superintendent of Documents, U. S. Printing Office, Washington 25, D. C. Price 30 cents.

STRENGTH AND WEAKNESSES OF THE JUNIOR HIGH SCHOOL. Report of the National Conference on Junior High Schools, Washington, D. C., February 24–26, 1955, Compiled by Walter H. Gaumnitz, *Specialist, Secondary Education.* Paper. Pages vi+56. 20×26 cm. Superintendent of Documents, U. S. Printing Office, Washington 25, D. C. Price 40 cents.

HOW YOU CAN SEARCH FOR SCIENCE TALENT. A Book of Facts about the Fifteenth Annual Science Talent Search for Westinghouse Science Scholarships. Paper. 22 pages. 13.5×20.5 cm. Science Clubs of America, 1719 N Street, N.W., Washington 6, D. C.

MATH PROBLEMS FROM INDUSTRY, by Chrysler Corporation. Paper. 52 pages. 21.5×28 cm. Educational Services, Department of Public Relations, Chrysler Corporation, Box 1919, Detroit 31, Mich.

BOOK REVIEWS

DOWN TO EARTH, by Robin Place, M.A., *First Class Honours, Archaeological and Anthropological Tripos, Cambridge.* Cloth. Pages xvi+173. 13×21.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $7.50.

This practical guide to archaeology begins with the life of old stone age peoples. The illustrations are mainly from the British Isles. It describes the fundamentals of finding sites, organizing a "dig," excavating caves, camps and settlements as well as recording and interpreting the data from which the everyday life of the prehistoric peoples is reconstructed.

There are three parts of approximately six chapters each. These are: "The Use of Finds to Reconstruct Everyday Life," "Archaeological Excavation" and "Dating Britain's Past." There are eighty-eight illustrations to supplement the text.

PAUL E. KAMBLEY
University of Oregon
Eugene, Oregon

SCIENCE AND ITS BACKGROUND, Second Edition by H. D. Anthony, Headmaster, *Kilburn Grammar School,* London. Cloth. Pages ix+337. 12.5×19.5 cm. 1954. St. Martin's Press, 103 Park Avenue, New York 17, N. Y. Price $4.00.

This is the second edition of a book originally published in 1948. This edition has two new chapters on "The Utilization of Science" and on "Science for Its Own Sake." The book is unique, in part because it presents the story of science together with the background of history in which that story is set.

There are twenty-four chapters beginning with "Geological Time and Human History" and ending with "Man's Place in Nature." Other representative chapter titles are "Classification and Basic Principles," "The Medieval Universities," "The Break with Tradition," "Invention and Industry" and "Diminishing Distances."

It is a small, well-written book that can be read by most junior and senior high school students. Since the author is British there is naturally a heavy emphasis on the contributions of British scientists during the past one hundred years.

The chief criticism of the book is the small size of print. This is likely to discourage younger readers.

PAUL E. KAMBLEY

THE GIFTED STUDENT AS FUTURE SCIENTIST, by Paul F. Brandwein, *Chairman, Science Department, Forest Hills High School, New York, N. Y.* Cloth. Pages xvi+107. 12.5×20.5 cm. 1955. Harcourt, Brace and Company, Inc., 383 Madison Avenue, New York 17, N. Y.

According to the author the purpose of this book is six-fold. First is the formulation of a conceptual scheme which may be useful in determining the nature of high ability in science. Second is the description in detail of one type of program which has been somewhat successful in stimulating the development of youngsters with high ability in science. Third is a description of available tests which have promise in identifying these youngsters. Fourth is a description of the behavior of these youngsters at work. Fifth is a description of the kind of teacher who seems to be successful in working with these youngsters. Sixth are some proposals concerned with specific problems on the local, state, and national levels.

Those teachers who believe that the educational curriculum is geared to the average student and that gifted students should not be left to "their own educational devices" will get considerable practical help from this book.

PAUL E. KAMBLEY

ANALYTIC GEOMETRY, by Ross R. Middlemiss, *Professor of Mathematics, Washington University*. Second Edition. Cloth. Pages ix+310. 16×23.5 cm. 1955. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York, N. Y. Price $3.75.

Although to some extent a traditional text—at least this is an analytic geometry, not a combination of analytic geometry and calculus—the author has diminished the amount of space often devoted to the conics, with increased emphasis on the topics of polynomials, rational fractional functions, and the elementary transcendental functions. The treatment of curve fitting occupies nineteen pages, that of solid analytic geometry 48 pages.

As a result of the change in emphasis, some traditional topics are found only as exercises (for example, the normal form of the equation of a line, the radical axis of two circles) and others are omitted altogether. Whether this is a good or bad feature will depend upon the type of text desired by the individual instructor. Again, the individual teacher may or may not be pleased with the concept that the distance from a line to a point is undirected, in contrast to the convention in some other texts. The author points out the fact that there are two distinct polar coordinate systems, depending upon the admission or non-admission of negative values for ρ.

The number of exercises seems ample for alternate assignments in successive school terms. This reviewer was pleased with the care which the author has taken to make his statements rigorous, or at least to point out that there is no need to consider cases which might lead to difficulty—for example 0^0, a^x where x is irrational, *arcsec* x and *arccsc* x. It seemed, however, that in a few places there was undue elimination of topics—as a single case, the discussion of symmetry in polar coordinates.

For classes interested in the emphasis which has been rather briefly indicated, this text should receive very serious consideration.

CECIL B. READ
University of Wichita
Wichita, Kansas

ANALYTIC GEOMETRY, by Neal H. McCoy and Richard E. Johnson, *Department of Mathematics, Smith College*. Cloth. Pages xiv+301. 16×23.5 cm. 1955. Rhinehart and Company, New York, N. Y. Price $4.00.

This might be classified as a traditional type text in analytic geometry, although at several points the authors have designated material as optional—for example, the normal form of the equation of a line, circles through the intersection of two circles, equivalent equations and intersections of curves in polar coordinates (although this particular section is, in the opinion of the reviewer, one of the best he has seen), cylindrical and spheric coordinates.

There seems to be care in the phrasing of the statements, no statements were noted which are not true under certain conditions, as is often the case. The problem lists, although perhaps longer than might be needed for a single class, are hardly long enough to provide alternate assignments in various terms. This is particularly annoying when after a short problem list one finds a considerable amount of the page left blank. In the treatment of symmetry, in the discussion of curves in rectangular coordinates, one wonders why the conditions were not made to cover the situation "if and only if"; in the case of polar curves, the topic is omitted entirely.

Although in one place it is pointed out that it is not necessary to use the same scale on both axes, many teachers will object to graphs of trigonometric equations, such as on pages 162–165, where the scales are not equal, yet so nearly so that one sees no good reason for the variation.

The criticisms mentioned are relatively minor, on the whole this seems to be a text definitely above average in quality, and certainly one which must be considered as a possibility for a course with objectives of the somewhat traditional type.

CECIL B. READ

COLLEGE ALGEBRA, REVISED EDITION, by Paul R. Rider, Ph. D., *Chief Statistician, Aeronautical Research Laboratory, Wright-Patterson Air Force Base, Professor Emeritus of Mathematics, Washington University*. Cloth. Pages xiv+397. 14.5×21 cm. 1955. The Macmillan Company, New York, N. Y. Price $4.00.

This text covers the usual topics of college algebra, the coverage being more extensive than some brief texts, including such topics as infinite series, compound interest and annuities, solution of the general cubic and quartic, partial fractions, Horner's method (and an optional method which is essentially graphic interpolation). Statistics is not covered. The text covers more material of an elementary nature than is found in many texts, in fact it could no doubt be used for both intermediate and college algebra.

There are ample problems, answers are given to odd numbered exercises, with an answer pamphlet for even numbered exercises available to students upon request of the instructor (and hence no doubt available to at least some students at neighboring institutions, contrary to the desires of the instructor).

In general the treatment is good, some few points displeased this reviewer. Problem 24 on page 14, involving nests of parentheses, and the use of the vinculum, seems artificial; on the other hand, the following problem which involves the absolute value sign within parentheses, is unusual and of definite merit. Laws of exponents stated on page 80 place the restriction that the denominator cannot be zero in a place where it might be overlooked by the student. On page 13 the student might wonder *why* he should not assign values of 0 or 1 in checking; again on page 171 he might ask *why* a solution is correct to three decimal places. The discussion on page 189 seems to require that the point (0, 0) be excluded from the axis of imaginary numbers; another approach might be that zero is the only number common to pure imaginaries and to reals. The statement on page 241 that for numbers having the same sequence of digits the decimal part of the logarithm is the same is simply not true. It might be made true with minor restrictions, but the footnote on the same page shows that the author has not required that the decimal portion of the logarithm be positive.

A somewhat unusual treatment of the expansion of a determinant is used, whether this will appeal to the teacher is perhaps a matter of personal opinion. The same statement is applicable to the authors rule for the characteristic of a logarithm—there may or may not be gain in introducing the concept of "standard position" of a decimal point.

Tables include powers and roots, four place common logarithms, compound amount and present value, amount and present value of an annuity (these four tables are rather condensed—fifty periods are covered, with interest rates ranging from 1 to 7%), four place values of trigonometric functions, and the 1941 CSO mortality table.

CECIL B. READ

YOUR CAREER IN PHYSICS, by Philip Pollack. Cloth. Pages 127. 14×20.5 cm. 1955. E. P. Dutton & Co., Inc. 300 Fourth Ave., New York 10, New York. Price $2.75.

In this authoritative vocational guide, Mr. Pollack follows the same pattern he established in his preceding volume, *Careers and Opportunities in Science* (see SCHOOL SCIENCE & MATHEMATICS, LV: (June 1955), pp. 500–1), with the exception that he pinpoints the outstanding opportunities in one field only viz: physics, rather than science in general. The first chapter gives a brief historical sketch of the field with implications of the value of the most important laws and discoveries. This is followed by the aptitudes and qualifications required to be a professional physicist. Although encouraging in most of its detail, the discussion of expected salary is not an item that will bring droves of budding physicists into the profession.

A detailed description of the kind of activity that can be expected in Electronics, Atomic Energy, Optometry, Aeronautics, Meteorology and power production fills the major portion of the book. The most informative section that

would be of value in counseling students is the extensive bibliography and the appendix which lists the important institutions which should be considered when contemplating a career in physics. There is also a description of the many professional societies, journals, and a brief bibliography.

The many science vignettes that are sprinkled throughout the career descriptions make for interesting reading. There are several clear black and white photographs of outstanding physicists working in their laboratories and demonstrating their typical specialized equipment. Except for possible salary changes, the use of this little manual as an inspiring counseling device would be changed very little by the passage of time.

JOHN D. WOOLEVER
Mumford High School
Detroit, Michigan

OUR WONDERFUL EYES, by John Perry. Cloth. Pages 159. 14×20.5 cm. 1955. Whittlesey House Books, McGraw-Hill Book Co., Inc. 330 West 42nd Street, New York 36, N. Y. Price $2.75.

In spite of the complexity of the subject, the author has done a superior job in clarifying the subject of vision for young people. He divides his subject into fifteen unnumbered chapters. The subject is introduced by the importance of human vision and the nature of light. The structure of the eye and how we see with our eyes and brain are explained very thoroughly with a minimum of technical terms.

Two subjects of utmost interest to children and handled extremely well are entitled "What animals see" and "Pictures and Illusions." The latter having the most functional illustrations found in the book.

Without preaching, proper care of the eyes is covered in detailed simplicity and has more information and advice on this subject than most health and hygiene texts. This is followed by "What it's like to be blind," an unusual chapter that might have been written by a blind man explaining his world to unbelieving strangers. This unusual chapter describes the life a of blind person in fascinating detail.

In the final chapter the author emphasizes the relatively small amount of information covered in the book compared to what is available if the young reader is interested enough to continue on with the subject. Many oddities of vision that did not fit into preceding chapters such as psychology, art and color are touched upon, before the book is terminated. Unfortunately no bibliography is listed for those who would like to pursue the subject further.

The author uses a simple style addressing the reader directly, and frequently suggesting experiments with simple home equipment, emphasizing the why and how of it all. Whenever descriptions or demonstrations cannot be drawn from the experiences of the reader, very simple but effective diagrams supplement the material.

The type is large, sentences are short and no subject is drawn out beyond a child's immediate interest. Although this little book is intended for elementary children, high school students would have much to gain if it were made available to them.

JOHN D. WOOLEVER

USING CHEMISTRY, by Oscar E. Lanford, *Dean, College at New York State College for Teachers*. Cloth. Pages 722. 14.5×23 cm. 1955. McGraw-Hill Book Company, Inc. 330 West 42nd St., New York, 36, New York. Price $4.56.

Although designed for both practical and college preparatory chemistry classes, this new text leans toward the college student so much that it could be used in introductory college chemistry courses. The content is rather voluminous for the slower student but the sentence structure is short and direct, to the benefit of high school students with reading difficulties. It is up to date with implications of the importance of chemistry in our political and economic structures. It

stresses the immense growth and expansion of the science in all phases of world progress.

Subject matter is divided into twelve major units, each varying in the number of chapters which total fifty-two. The largest units revolve about Atomics-Carbon and Metals, each with more than a hundred pages. More than the usual amount of attention is paid to human nutrition and mineral conservation. Key words are either in heavy type or italics, appearing at the end of each chapter also. Chapter reviews are short, followed by a few recall questions. Each unit suggests projects revolving about community resources, computations or library research.

The book does not lack equations, every process is detailed although the method of balancing oxidation-reduction equations appears in unit twelve and isn't really needed until chapter twenty-seven. This is because the author was careful in organizing the chapters so that almost any one of them may be omitted without destroying the continuity. This flexibility also makes it possible to use any laboratory manual with this text.

There is the usual number of commercial photographs and a wealth of tables and graphs. For schools whose students can't handle a book of this magnitude, it would be a good supplement to the library. Students mastering this book would have an excellent background for college chemistry.

JOHN D. WOOLEVER

ANTHROPOLOGY, by J. E. Manchip White, (M A Contab), Cloth. Pages viii+191. 10.5×17.5 cm. 1954. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $2.75.

"It is the task of the anthropologist to explain man to himself," says author White. That he does in words that all can understand.

After a brief introduction are chapters on: Physical, Cultural and Social Antropology followed by a concluding one on how the anthropologist works and how he helps One World to become ONE without total loss of the assets to be found even in the most primitive cultures.

How has man come to his present biological status? Whence such diverse outcomes from man's reactions to his fellows and his other environment? Is there evidence that these differences stem from differing intelligence potentials? What hazards are encountered when one culture group attempts to induce elements of its pattern into that of another culture? These and many more significant topics are given helpful consideration.

The book is intended as an introduction to the subject. In keeping with that purpose it is written in English that is more vernacular than technical. Each chapter is preceded by a spread of its items to be treated: a sort of pre-digest of that unit's offering. Five figures and five full page plates add to the clarity of the exposition. Each chapter is followed by lists of "books for further study." There is no index.

The author, a Welshman by birth, has honors degrees from Cambridge, (England) in: English Literature, Archeology and Egyptology; and a diploma in Anthropology. His authorship has produced two novels, three books of poems as well as a scholarly volume on Ancient Egypt.

At a time in this world's history when no group can entirely escape contact with many of the others books of this character may be extra-pertinent in the training of that world's leadership.

B. CLIFFORD HENDRICKS
Longview, Washington

ELEMENTS OF PHYSICS, SECOND EDITION, by George Shortley, B.E.E., Ph.D., Operations Research Office, The Johns Hopkins University, *Formerly Professor of Physics, The Ohio State University;* and Dudley Williams, A.B., Ph.D., *Professor of Physics, The Ohio State University.* Cloth. Pages xiv+880+xviii. 14.5×23 cm. 1955. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N.Y.

In the two years that the First Edition of this text has been in use it has proven its value as a leading textbook of college physics. Now the authors present a thoroughly revised edition, with much new material, some rearrangement of topics into more logical order, new sets of problems, and many illustrative examples. Many new topics have been included. Here we find new material on thermionic vacuum tubes, transistors, fluid viscosity, relative velocities, dynamical systems, and the newly discovered particles of modern physics. Many teachers, who have not had the opportunity of taking courses in modern physics will find the last two chapters extremely helpful.

For most classes teachers will find the 853 pages of text and problems entirely too much for a year's work, hence careful selection of both topics and problems will be necessary. Each department adopting the text should spend a considerable amount of time working through the text to find out what they can best afford to omit in order to give their classes the most effective course for the time allotted to physics. The material is here and well presented. If it does not seem to be a success in your classes, try a more thorough study of your plan of study assignments and your selection of material. We consider this text one of the very best in the field and well suited for students in their sophomore year while they are taking their regular courses in the calculus.

G. W. W.

HOW THE EARTH IS MADE, by Peter Hood. Cloth. Pages 64. 17×23.2 cm. 1954 Oxford University Press, Amen House, London E.C. 4, England. Price $2.50

This volume is one of the *Oxford Visual Series* that deals with physical and natural science. In general it is designed to arouse the interest of the beginner and to present material in a simple way that can be understood by those who have no previous knowledge of the subjects.

How the Earth Is Made describes in simple language with many drawings and photographs the geology and history of the earth—how rocks are formed, how mountains, rivers and coasts have come to their present shape, where coal and oil are found, and the history of the evolution of plants, animals and man. The above information is found on the jacket and in so far as the reviewer can ascertain is correct. Unfortunately, it fails to indicate that the examples, pictures and applications are drawn *in toto* from the British Isles. While they may be of value for the beginner of that country, the information would not deal directly with the experiences of the "beginner" in the United States.

The reviewer is also doubtful that any beginner could obtain from this publication many insights into the earth's changes. Entirely too much is attempted in the limited pagination.

The material is simple; it is clear; and it is extensive. However, it is of greater value as a *review* of the area rather than as an *introduction*. A beginner just couldn't understand all that is covered in such a cursory manner.

GEORGE G. MALLINSON
Western Michigan College
Kalamazoo, Michigan

ICE IS THAT WAY BECAUSE OF LIQUID WATER FILM

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MILLION-HOUR TRANSISTORS ARE ON THE WAY

Electronic devices with far longer life expectancy are on the way with the announcement that transistors are being developed that can last more than a century.

Dr. Donald G. Fink, director of research for the Philco Corporation, revealed that two electronics firms now have the know-how to build such transistors that will far outlive the best of today's tubes. A high quality vacuum tube, such as is used in the transatlantic telephone cable now being laid, lasts about 40 years.

The new transistor's life is so long that the estimated lifetime cannot be checked. Accelerated tests are being worked out. The tiny transistors are also rugged enough to stand a physical beating, Dr. Fink told a meeting of the Institute of Radio Engineers.

Transistors are pea-sized crystal devices that are gradually taking over the function of vacuum tubes in radios, hearing aids and advanced electronic devices.

They can achieve the long (million-hour) life expectancy without expensive design techniques or costly production methods such as are needed to increase the life of fragile vacuum tubes.

In an aircraft autopilot device, for instance, replacement of vacuum tubes with the million-hour transistors will make it extremely unlikely that the device would fail in thousands of hours.

Transistors, Dr. Fink said, burn out, but not because of exhaustion as do tubes. They fail for a number of other reasons, including overheating.

At present, transistors cannot work with the heavy power loads that today's tubes can handle, but it was predicted that with larger germanium crystals, the transistor could eventually take over most of the vast number of functions of vacuum tubes.

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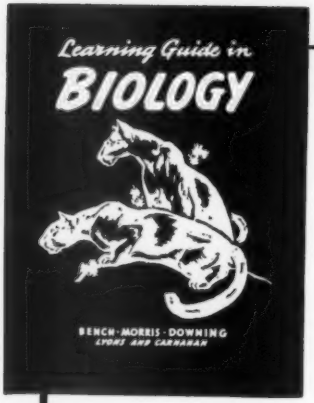

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